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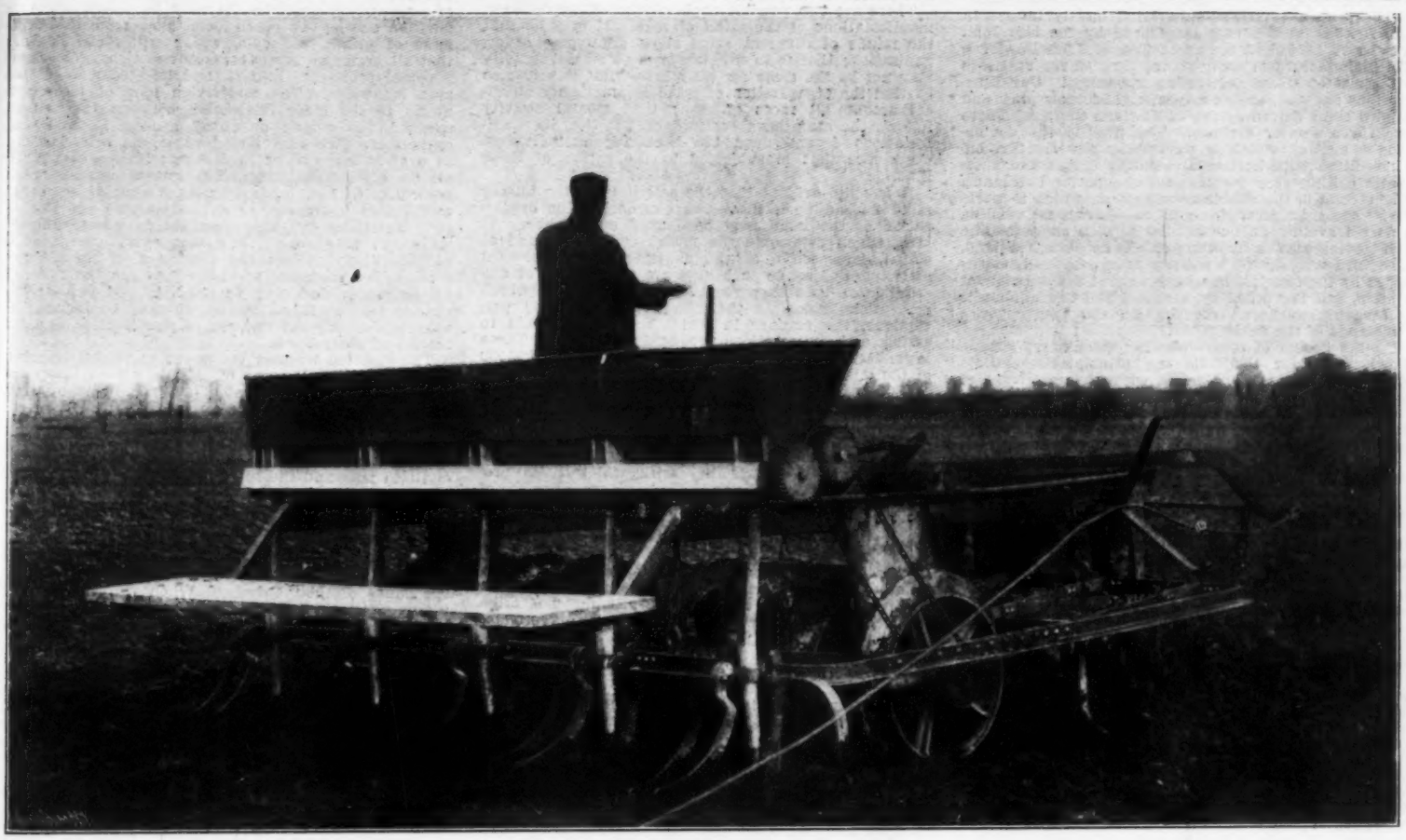
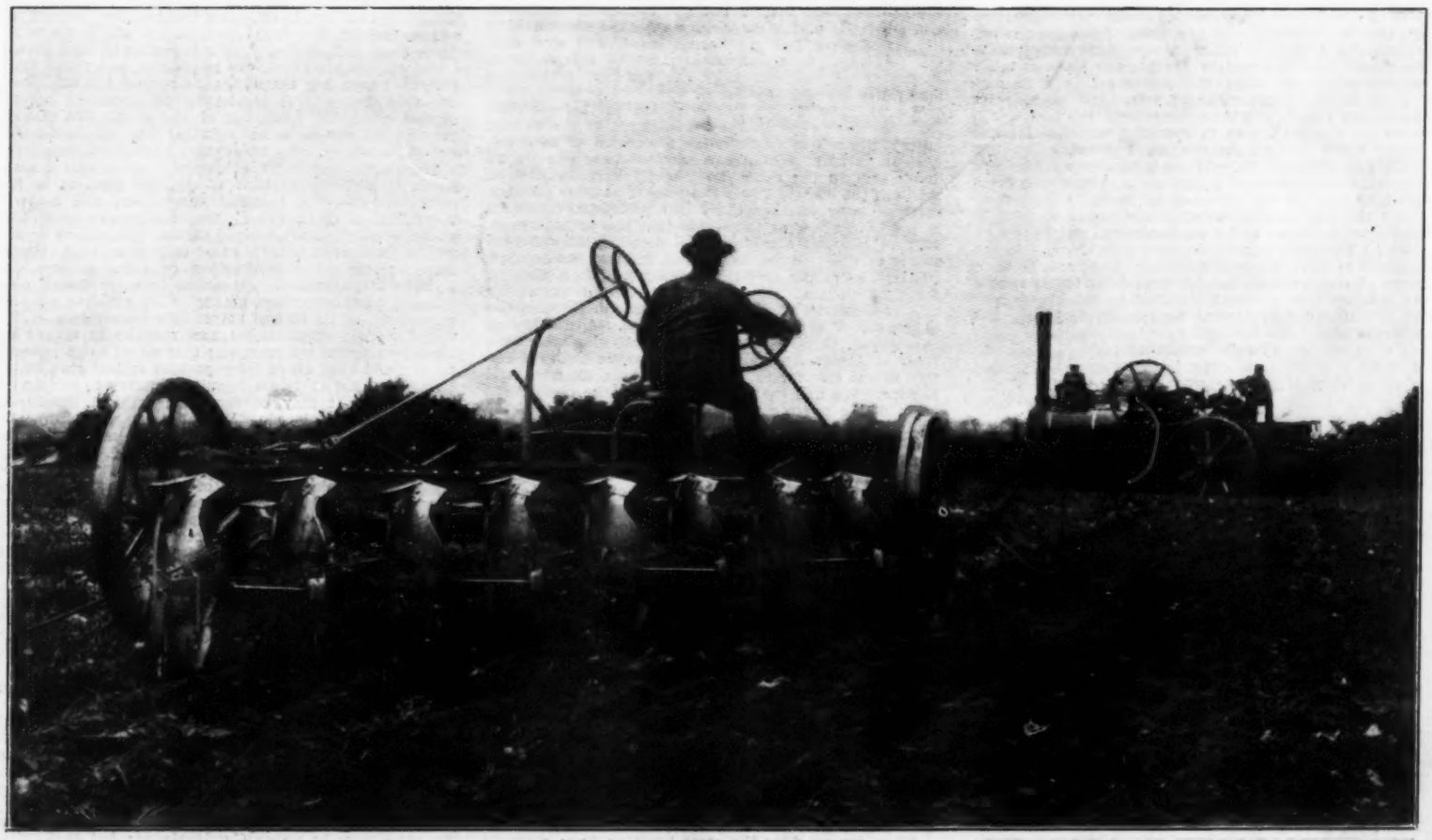


STEAM PLOWING WITH FOWLER'S ENGINE.



ENGINE-DRIVEN EIGHT-FURROW PLOW.

MOTORS IN AGRICULTURE.

MOTORS IN AGRICULTURE.*

By the LONDON CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

THE Right Hon. R. W. Hanbury, M. P., British Minister for Agriculture, referred to the motor, the other day, as the "farmer's hope." Up to the present, however, mechanical power has only to a very small extent superseded animal labor in Great Britain in the various operations of farming, and the British farmer is far behind the agriculturists of the Western States of America in this respect. This is not to be wondered at, for farming in Britain has long been a depressed industry; the farmer's capital is small and his initiative slender; he fears to embark on new enterprises and to adopt new methods. The huge farms to be found in the United States of America have no counterpart in this country, and it is therefore not surprising that American mechanical methods should be greatly superior to British.

The system of steam cultivation mostly in use in the British Isles is that introduced by the late John Fowler in 1850, and the great firm of John Fowler & Co. manufacture at their steam plow works at Leeds all kinds of steam cultivating apparatus. Our illustrations show an engine-driven, eight-furrow plow and a plow being driven by one of Fowler's engines. There are three Fowler systems. The first is the double-engine system, which is worked by *two* traction engines fitted with horizontal winding drums and automatic coiling gear moving along opposite headlands. The second is the double-drum system, which is worked by *one* traction engine with two horizontal winding drums traveling on one headland, with an automatic self-moving anchor traveling on the opposite headland. The third system, which has now been practically superseded by the two just named, is termed the roundabout system, and is worked by windlass and two automatic self-moving anchors, traveling on the two opposite headlands of the field.

In the design of steam plowing machinery, Messrs. Fowler consider the following principles essential: A direct pull on the implement without interference of pulleys and snatch blocks; the use of the smallest possible amount of wire rope; great facility for moving the machinery from field to field; and the employment of a minimum of manual or animal labor.

In the first two systems described these conditions are fulfilled in the most complete manner. The horizontal position of the winding drum permits the rope to work direct at any angle required by the line of the furrows, and the engine, with the complete winding apparatus attached to it, is at any moment ready to move itself and implements from field to field. The first cost of a double-engine tackle is necessarily heavy, but experience has shown that it is really in the long run a profitable investment.

The advantages of steam cultivation may be summed up as follows: The work can be done at the right season of the year; better tillage; expedition; thorough aeration of the soil, and consequently better crops; great economy in time and labor, and ability to reclaim land which otherwise it would be most difficult to cultivate. The aeration of the soil is one of the principal objects of cultivation, and the rapid motion of a steam-driven implement tears and breaks up the land so that it remains in a loose, rough state; the atmosphere acting upon the subsoil permanently raises the temperature, pulverizes the whole by degrees, and thoroughly prepares it for the reception of the seed. The consolidation of the land due to treading of animals is avoided, the drainage is improved, and the roots of plants can readily penetrate the subsoil.

In the double-engine system of steam cultivation, two self-moving plowing engines (with patent winding drums and automatic coiling gear) work on opposite headlands, each alternately hauling the plow or other implement toward itself, the engine not in work paying out its rope while moving forward into position for the return journey. This arrangement requires no fixtures in the field, and is specially suitable for the heavy work of cultivation and harrowing, rolling, draining, drilling, etc. The hauling ropes are also available for removing roots, rocks, trees, etc., from the land and for the transport of heavy produce from the fields, and also for winding the engine and implements across rough and steep banks and gulches.

Many hundreds of sets of plowing tackle on this system are at work all over the world, and from 30 to 50 acres of regular work can be done daily by its means. At the last trial of steam cultivating machinery held by the Royal Agricultural Society of England, this system gained the first prize.

(To be continued.)

THE MIND OF PRIMITIVE MAN.†

By FRANZ BOAS.

ONE of the chief aims of anthropology is the study of the mind of man under the varying conditions of race and of environment. The activities of the mind manifest themselves in thoughts and actions, and exhibit an infinite variety of form among the peoples of the world. In order to understand these clearly, the student must endeavor to divest himself entirely of opinions and emotions based upon the peculiar social environment into which he is born. He must adapt his own mind, so far as feasible, to that of the people whom he is studying. The more successful he is in freeing himself from the bias based on the group of ideas that constitute the civilization in which he lives, the more successful he will be in interpreting the beliefs and actions of man. He must follow lines of thought that are new to him. He must participate in new emotions, and understand how, under unwonted conditions, both lead to actions. Beliefs, customs, and the response of the individual to the events of daily life give us ample opportunity to observe the manifestations of the mind under varying conditions.

The thoughts and actions of civilized man and those found in more primitive forms of society prove that, in various groups of mankind, the mind responds quite differently when exposed to the same conditions. Lack of logical connection in its conclusions, lack of control of will, are apparently two of its fundamental characteristics in primitive society. In the formation of opinions, belief takes the place of logical demonstration. The emotional value of opinions is great, and consequently they quickly lead to action. The will appears unbalanced, there being a readiness to yield to strong emotions, and a stubborn resistance in trifling matters.

In the following remarks I propose to analyze the differences which characterize the mental life of man in various stages of culture. It is a pleasant duty to acknowledge here my indebtedness to my friends and colleagues in New York, particularly to Dr. Livingston Farrand, with whom the questions here propounded have been a frequent theme of animated discussion, so much so, that at the present time I find it impossible to say what share the suggestions of each had in the development of the conclusions reached.

There are two possible explanations of the different manifestations of the mind of man. It may be that the minds of different races show differences of organization; that is to say, the laws of mental activity may not be the same for all minds. But it may also be that the organization of mind is practically identical among all races of man; that mental activity follows the same laws everywhere, but that its manifestations depend upon the character of individual experience that is subjected to the action of these laws.

It is quite evident that the activities of the human mind depend upon these two elements. The organization of the mind may be defined as the group of laws which determine the modes of thought and of action, irrespective of the subject-matter of mental activity. Subject to such laws are the manner of discrimination between perceptions, the manner in which perceptions associate themselves with previous perceptions, the manner in which a stimulus leads to action, and the emotions produced by stimuli. These laws determine to a great extent the manifestations of the mind.

But, on the other hand, the influence of individual experience can easily be shown to be very great. The bulk of the experience of man is gained from oft-repeated impressions. It is one of the fundamental laws of psychology that the repetition of mental processes increases the facility with which these processes are performed, and decreases the degree of consciousness that accompanies them. This law expresses the well-known phenomena of habit. When a certain perception is frequently associated with another previous perception, the one will habitually call forth the other. When a certain stimulus frequently results in a certain action, it will tend to call forth habitually the same action. If a stimulus has often produced a certain emotion, it will tend to reproduce it every time.

The explanation of the activity of the mind of man, therefore, requires the discussion of two distinct problems. The first bears upon the question of unity or diversity of organization of the mind, while the second bears upon the diversity produced by the variety of contents of the mind as found in the various social and geographical environments. The task of the investigator consists largely in separating these two causes and in attributing to each its proper share in the development of the peculiarities of the mind. It is the latter problem, principally, which is of interest to the folk-lorist. When we define as folk-lore the total mass of traditional matter present in the mind of a given people at any given time, we recognize that this matter must influence the opinions and activities of the people more or less according to its quantitative and qualitative value, and also that the actions of each individual must be influenced to a greater or less extent by the mass of traditional material present in his mind.

We will first devote our attention to the question, Do differences exist in the organization of the human mind? Since Waitz's thorough discussion of the question of unity of the human species there can be no doubt that in the main the mental characteristics of man are the same all over the world; but the question remains open whether there is a sufficient difference in grade to allow us to assume that the present races of man may be considered as standing on different stages of the evolutionary series, whether we are justified in ascribing to civilized man a higher place in organization that to primitive man. In answering this question we must clearly distinguish between the influences of civilization and of race. A number of anatomical facts point to the conclusion that the races of Africa, Australia, and Melanesia are to a certain extent inferior to the races of Asia, America, and Europe. We find that on the average the size of the brain of the negroid races is less than the size of the brain of the other races; and the difference in favor of the mongoloid and white races is so great that we are justified in assuming a certain correlation between their mental ability and the increased size of their brain. At the same time it must be borne in mind that the variability of the mongoloid and white races on the one hand and of the negroid races on the other is so great that only a small number, comparatively speaking, of individuals belonging to the latter have brains smaller than any brains found among the former; and that, on the other hand, only a few individuals of the mongoloid races have brains so large that they would not occur at all among the black races. That is to say, the bulk of the two groups of races have brains of the same capacities, but individuals with heavy brains are proportionately more frequent among the mongoloid and white races than among the negroid races. Probably this difference in the size of the brain is accompanied by differences in structure, although no satisfactory information on this point is available. On the other hand, if we compare civilized people of any race with uncivilized people of the same race, we do not find any anatomical differences which would justify us in assuming any fundamental differences in mental constitution.

When we consider the same question from a purely psychological point of view, we recognize that one of the most fundamental traits which distinguish the human mind from the animal mind is common to all races of man. It is doubtful if any animal is able to form an abstract conception, such as that of number, or any conception of the abstract relations of phenomena. We find that this is done by all races of man. A developed language with grammatical categories presupposes the ability of expressing abstract relations, and, since every known language has grammatical structure, we must assume that the faculty of forming abstract ideas is a common property of man. It has often been pointed out that the concept of number is developed very differently among different peoples. While in most languages we find numeral systems based upon the 10, we find that certain tribes in Brazil, and others in Australia, have numeral systems based on the 3, or even on the 2, which involve the impossibility of expressing high numbers. Although these numeral systems are very slightly developed as compared with our own, we must not forget that the abstract idea of number must be present among these people, because without it no method of counting is possible. It may be worth while to mention one or two other facts taken from the grammars of primitive people, which will make it clear that all grammar presupposes abstractions. The three personal pronouns—I, thou, and he—occur in all human languages. The underlying idea of these pronouns is the clear distinction between the self as speaker, the person or object spoken to, and that spoken of. We also find that nouns are classified in a great many ways in different languages. While all the older Indo-European languages classify nouns according to sex, other languages classify nouns as animate or inanimate, or as human and not human, etc. Activities are also classified in many different ways. It is at once clear that every classification of this kind involves the formation of an abstract idea. The processes of abstraction are the same in all languages, and they do not need any further discussion, except in so far as we may be inclined to value differently the systems of classification and the results of abstraction.

The question whether the power to inhibit impulses is the same in all races of man is not so easily answered. It is an impression obtained by many travelers, and also based upon experiences gained in our own country, that primitive man and the less educated have in common a lack of control of emotions; that they give way more readily to an impulse than civilized man and the highly educated. I believe that this conception is based largely upon the neglect to consider the occasions on which a strong control of impulses is demanded in various forms of society. What I mean will become clear when I call your attention to the often described power of endurance exhibited by Indian captives who undergo torture at the hands of their enemies. When we want to gain a true estimate of the power of primitive man to control impulses, we must not compare the control required on certain occasions among ourselves with the control exerted by primitive man on the same occasions. If, for instance, our social etiquette forbids the expression of feelings of personal discomfort and of anxiety, we must remember that personal etiquette among primitive men may not require any inhibition of the same kind. We must rather look for those occasions on which inhibition is required by the customs of primitive man. Such are, for instance, the numerous cases of taboo—that is, of prohibitions of the use of certain foods, or of the performance of certain kinds of work, which sometimes require a considerable amount of self-control. When an Eskimo community is on the point of starvation and their religious proscriptions forbid them to make use of the seals that are basking on the ice, the amount of self-control of the whole community which restrains them from killing these seals is certainly very great. Cases of this kind are very numerous, and prove that primitive man has the ability to control his impulses, but that his control is exerted on occasions which depend upon the character of the social life of the people, and which do not coincide with the occasions on which we expect and require control of impulses.

The third point in which the mind of primitive man seems to differ from that of civilized man is in its power of choosing between perceptions and actions according to their value. On this power rests the whole domain of art and of ethics. An object or an action becomes of artistic value only when it is chosen from among other perceptions or other actions on account of its beauty. An action becomes moral only when it is chosen from among other possible actions on account of its ethical value. No matter how crude the standards of primitive man may be in regard to these two points we recognize that all of them possess an art, and that all of them possess ethical standards. It may be that their art is quite contrary to our artistic feeling. It may be that their ethical standards outrage our moral code. We must clearly distinguish between the æsthetic and ethical codes and the existence of an æsthetic and ethical standard.

Our brief consideration of the phenomena of abstraction, of inhibition and of choice, leads, then, to the conclusion that these functions of the human mind are common to the whole of humanity. It may be well to state here that, according to our present method of considering biological and pyschological phenomena, we must assume that these functions of the human mind have developed from lower conditions existing at a previous time, and that at one time there certainly must have been races and tribes in which the properties here described were not at all, or only slightly, developed; but it is also true that among the present races of man, no matter how primitive they may be in comparison with ourselves, these faculties are highly developed.

It is not impossible that the degree of development of these functions may differ somewhat among different types of man; but I do not believe that we are able at the present time to form a just valuation of the power of abstraction, of control, and of choice among different races. A comparison of their languages, customs, and activities suggests that these faculties may be unequally developed; but the differences are not sufficient to justify us in ascribing materially lower stages to some peoples and higher stages to others. The conclusions reached from these con-

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

† Address of the retiring president before the American Folk-Lore Society, Baltimore, December 27, 1900. Reprinted from the Smithsonian Report for 1901.

siderations are therefore on the whole, negative. We are not inclined to consider the mental organization of different races of man as differing in fundamental points.

We next turn to a consideration of the second question propounded here, namely, to an investigation of the influence of the contents of the mind upon the formation of thoughts and actions. We will take these up in the same order in which we considered the previous question. We will first direct our attention to the phenomena of perception. It has been observed by many travelers that the senses of primitive man are remarkably well trained; that he is an excellent observer. The adeptness of the experienced hunter, who finds the tracks of his game where the eye of a European would not see the faintest indication, is an instance of this kind. While the power of perception of primitive man is excellent, it would seem that his power of logical interpretation of perceptions is deficient. I think it can be shown that the reason for this fact is not founded on any fundamental peculiarity of the mind of primitive man, but lies, rather, in the character of the ideas with which the new perception associates itself. In our own community a mass of observations and of thoughts is transmitted to the child. These thoughts are the result of careful observation and speculation of our present and of past generations; but they are transmitted to most individuals as traditional matter, much the same as folklore. The child associates new perceptions with this whole mass of traditional material, and interprets his observations by its means. I believe it is a mistake to assume that the interpretation made by each civilized individual is a complete logical process. We associate a phenomenon with a number of known facts, the interpretations of which are assumed as known, and we are satisfied with the reduction of a new fact to these previously known facts. For instance, if the average individual hears of the explosion of a previously unknown chemical, he is satisfied to reason that certain materials are known to have the property of exploding under proper conditions, and that consequently the unknown substance has the same quality. On the whole, I do not think that we should try to argue still further, and really try to give a full explanation of the causes of the explosion.

The difference in the mode of thought of primitive man and of civilized man seems to consist largely in the difference of character of the traditional material with which the new perception associates itself. The instruction given to a child of primitive man is not based on centuries of experimentation, but consists of the crude experience of generations. When a new experience enters the mind of primitive man, the same process which we observe among civilized men brings about an entirely different series of associations, and therefore results in a different type of explanation. A sudden explosion will associate itself in his mind, perhaps, with tales which he has heard in regard to the mythical history of the world, and consequently will be accompanied by superstitious fear. When we recognize that, neither among civilized men nor among primitive men, the average individual carries to completion the attempt at casual explanation of phenomena, but carries it only so far as to amalgamate it with other previously known facts, we recognize that the result of the whole process depends entirely upon the character of the traditional material. Herein lies the immense importance of folklore in determining the mode of thought. Herein lies particularly the enormous influence of current philosophic opinion upon the masses of the people, and herein lies the influence of the dominant scientific theory upon the character of scientific work. It would be in vain to try to understand the development of modern science without an intelligent understanding of modern philosophy; it would be in vain to try to understand the history of mediæval science without an intelligent knowledge of mediæval theology; and so it is in vain to try to understand primitive science without an intelligent knowledge of primitive mythology. Mythology, theology, and philosophy are different terms for the same influences which shape the current of human thought and which determine the character of the attempts of man to explain the phenomena of nature. To primitive man—who has been taught to consider the heavenly orbs as animate beings, who sees in every animal a being more powerful than man, to whom the mountains, trees, and stones are endowed with life—explanations of phenomena will suggest themselves entirely different from those to which we are accustomed, since we base our conclusions upon the existence of matter and force as bringing about the observed results. If we do not consider it possible to explain the whole range of phenomena as the result of matter and force alone, all our explanations of natural phenomena must take a different aspect.

In scientific inquiries we should always be clear in our own minds of the fact that we do not carry the analysis of any given phenomenon to completion; but that we always embody a number of hypotheses and theories in our explanations. In fact, if we were to do so, progress would hardly become possible, because every phenomenon would require an endless amount of time for thorough treatment. We are only too apt, however, to forget entirely the general, and, for most of us, purely traditional, theoretical basis, which is the foundation of our reasoning, and to assume that the result of our reasoning is absolute truth. In this we commit the same error that is committed, and has been committed, by all the less civilized peoples. They are more easily satisfied than we are at the present time, but they also assume as true the traditional element which enters into their explanations, and therefore accept as absolute truth the conclusions based on it. It is evident that the fewer the number of traditional elements that enter into our reasoning, and the clearer we endeavor to be in regard to the hypothetical part of our reasoning, the more logical will be our conclusions. There is an undoubted tendency in the advance of civilization to eliminate traditional elements, and to gain a clearer and clearer insight into the hypothetical basis of our reasoning. It is therefore not surprising that, with the advance of civilization, reasoning becomes more and more logical, not because each individual carries out his thought in a more logical manner, but because the traditional material which is handed down to each individual has been thought out and worked out more thoroughly and more carefully. While in primitive civilization the traditional material is doubted and examined by only a very few individuals, the number of thinkers who try to free themselves from the fetters of tradition increases as civilization advances.

The influence of traditional material upon the life of man is not restricted to his thoughts, but manifests itself no less in his activities. The comparison between civilized man and primitive man in this respect is even more instructive than in the preceding case. A comparison between the modes of life of different nations, and particularly of civilized man and of primitive man, makes it clear that an enormous number of our actions are determined entirely by traditional associations. When we consider, for instance, the whole range of our daily life, we notice how strictly we are dependent upon tradition that cannot be accounted for by any logical reasoning. We eat our three meals every day, and feel unhappy if we have to forego one of them. There is no physiological reason which demands three meals a day, and we find that many people are satisfied with two meals, while others enjoy four or even more. The range of animals and plants which we utilize for food is limited, and we have a decided aversion against eating dogs, or horses, or cats. There is certainly no objective reason for such aversion, since a great many people consider dogs and horses as dainties. When we consider fashions, the same becomes still more apparent. To appear in the fashions of our forefathers of two centuries ago would be entirely out of the question and would expose one to ridicule. The same is true of table manners. To smack one's lips is considered decidedly bad style, and may even excite feelings of disgust, while among the Indians, for instance, it would be considered as in exceedingly bad taste not to smack one's lips when one is invited to dinner, because it would suggest that the guest does not enjoy his dinner. The whole range of actions that are considered as proper and improper cannot be explained by any logical reason, but are almost all entirely due to custom; that is to say, they are purely traditional. This is even true of customs which excite strong emotions, as, for instance, those produced by infractions of modesty.

While in the logical processes of the mind we find a decided tendency, with the development of civilization, to eliminate traditional elements, no such marked decrease in the force of traditional elements can be found in our activities. These are almost as much controlled by custom among ourselves as they are among primitive man. It is easily seen why this should be the case. The mental processes which enter into the development of judgments are based largely upon associations with previous judgments. I pointed out before that this process of association is the same among primitive men as among civilized men, and that the difference consists largely in the modification of the traditional material with which our new perceptions amalgamate. In the case of activities, the conditions are somewhat different. Here tradition manifests itself in an action performed by the individual. The more frequently this action is repeated, the more firmly it will become established, and the less will be the conscious equivalent accompanying the action; so that customary actions which are of very frequent repetition become entirely unconscious. Hand in hand with this decrease of consciousness goes an increase in the emotional value of the omission of such activities, and still more of the performance of actions contrary to custom. A greater will power is required to inhibit an action which had become well established; and combined with this effort of the will power are feelings of intense displeasure.

This leads us to the third problem, which is closely associated with the difference between the manifestation of the power of civilized man and of primitive man to inhibit impulses. It is the question of choice as dependent upon value. It is evident from the preceding remarks that, on the whole, we value most highly what conforms to our previous actions. This does not imply that it must be identical with our previous actions, but it must be on the line of development of our previous actions. This is particularly true of ethical concepts. No action can find the approval of a people which is fundamentally opposed to its customs and traditions. Among ourselves it is considered proper and a matter of course to treat the old with respect, for children to look after the welfare of their aged parents; and not to do so would be considered base ingratitude. Among the Eskimo we find an entirely different standard. It is required of children to kill their parents when they have become so old as to be helpless and no longer of any use to the family or to the community. It would be considered a breach of filial duty not to kill the aged parent. Revolting though this custom may seem to us, it is founded on an ethical law of the Eskimo, which rests on the whole mass of traditional lore and custom.

One of the best examples of this kind is found in the relation between individuals belonging to different tribes. There are a number of primitive hordes to whom every stranger not a member of the horde is an enemy, and where it is right to damage the enemy to the best of one's power and ability, and if possible to kill him. This custom is founded largely on the idea of the solidarity of the horde, and of the feeling that it is the duty of every member of the horde to destroy all possible enemies. Therefore every person not a member of the horde must be considered as belonging to a class entirely distinct from the members of the horde, and is treated accordingly. We can trace the gradual broadening of the feeling of fellowship during the advance of civilization. The feeling of fellowship in the horde expands to the feeling of unity of the tribe, to a recognition of bonds established by a neighborhood of habitat, and further on to the feeling of fellowship among members of nations. This seems to be the limit of the ethical concept of fellowship of man which we have reached at the present time. When we analyze the strong feeling of nationality which is so potent at the present time, we recognize that it consists largely in the idea of the preeminence of that community whose member we happen to be—in the pre-eminent value of its language, of its customs, and of its traditions, and in the belief that it is right to preserve its peculiarities and to impose them upon the rest of the world. The feeling of nationality as here expressed, and the feeling of solidarity of the horde, are of the same order, although modified by the gradual expansion of the idea of fellowship; but the ethical point of view which makes it justifiable at the present time to increase the well-being of one nation at the cost of another, the tendency to value one's own civilization as higher than that of the whole race of mankind, are the same as those which prompt the actions of primitive man, who considers every stranger as an enemy, and who is not satisfied until the enemy is killed. It is somewhat difficult for us to recognize that the value which we attribute to our own civilization is due to the fact that we participate in this civilization, and that it has been controlling all our actions since the time of our birth; but it is certainly conceivable that there may be other civilizations, based perhaps on different traditions and on a different equilibrium of emotion and reason, which are of no less value than ours, although it may be impossible for us to appreciate their values without having grown up under their influence. The general theory of valuation of human activities, as taught by anthropological research, teaches us a higher tolerance than the one which we now profess.

Our considerations make it probable that the wide differences between the manifestations of the human mind in various stages of culture may be due almost entirely to the form of individual experience, which is determined by the geographical and social environment of the individual. It would seem that, in different races, the organization of the mind is on the whole alike, and that the varieties of mind found in different races do not exceed, perhaps not even reach, the amount of normal individual variation in each race. It has been indicated that, notwithstanding this similarity in the form of individual mental processes, the expression of mental activity of a community tends to show a characteristic historical development. From a comparative study of these changes among the races of man is derived our theory of the general development of human culture. But the development of culture must not be confounded with the development of mind. Culture is an expression of the achievements of the mind, and shows the cumulative effects of the activities of many minds. But it is not an expression of the organization of the minds constituting the community, which may in no way differ from the minds of a community occupying a much more advanced stage of culture.

THE CHANCES FOR YOUNG MEN.

RECENTLY a wealthy Chicago business man announced, in a public interview that the only hope for young men is to "get land." He repeated again and again. "Get land, get land! Go sixty miles from a railroad. Get land, and wait till the railroad comes—then you can sell your land and clip your coupons; but get land, and thereby put money in your purse. It's the only way to win, the only road to success." In a similar strain, though speaking of the nation, James J. Hill recently said:

"So far as I am personally concerned, I would put the money into irrigating ditches and reservoirs in order to furnish homes for the coming generations that are beginning to crowd each other already. There are some figures running in my mind. At the time the civil war closed we had a population of 34,000,000 and have been increasing at the rate of 1,600,000 every year since. At that rate the gain in twenty-two years will equal the entire population in 1865. The census reports since 1790 show that we double our population every thirty years. At the close of the civil war all the land in Northern Wisconsin, Western Iowa, Western Minnesota and west of the Mississippi River to the Pacific Ocean was practically vacant. To-day, speaking generally, there is no arable land to be had anywhere upon the public domain. There is not an acre of public land where a man can raise a crop of potatoes or grain without irrigation. If that change has taken place within the last thirty-seven years, what shall we expect in the next thirty-seven years? Where are the people to live who come to us from foreign countries at the rate of half a million a year, and what are we going to do with the natural increase of our own people? The Northwest is already getting so crowded that 25,000 farmers have gone over the line into British Columbia. The Canadians claim 75,000, but that is excessive. They were good farmers, industrious, intelligent, and well-to-do, and had the capital to buy outright from 1,000 to 2,000 acres of land from the Dominion government, and have taken the oath of allegiance to King Edward. We could have kept them on our own side of the border if we could have given them irrigated lands."

Continuing his discussion of commercial conditions, with an eye to the future, the sage of the Great Northern said:

"There is to be an enormous development in China. They are getting ready for it over there. Our exports increased rapidly until the Boxer rebellion, when business was all broken up for about two years, but it has been resumed and is growing faster than before. But there is great danger that the United States may not be able to participate in the profits for several reasons. In the first place, our American manufacturers dropped the trade when they found they could sell goods with equal advantage in the home market. They were very short-sighted. When business was dull in the United States we gave a very low rate on all kinds of freight. We carried wire, nails, and commercial iron of all descriptions from Buffalo and Cleveland to Hong Kong for 45 cents a hundred, and flour, 40 cents a hundred, the same price you pay to have a trunk taken to a railway station, and we gave a similar rate to Australia from all Lake Erie ports—2,000 miles by rail and 8,000 miles by sea; while the rate to New York was 25 cents a hundred in the summer and 30 cents in

the winter. The merchants and manufacturers who went into it did a good business until business began to pick up here in the United States, when they concluded that they would rather sell their goods at home than ship them to China. Hence the effort to find a market for general merchandise in the East was practically abandoned. Our merchants voluntarily withdrew, the Germans went in and got the trade and will keep it. It's the same old story; you have heard it over and over again. The experience has been repeated in Brazil and Africa and elsewhere. When our manufacturers have a lot of goods they cannot sell at home they spend time and money working up a foreign trade, but as soon as the home market revives they neglect their foreign customers and lose them. We might have had the best of the Chinese trade if we had kept our boat in the stream, but it's all gone to be worked up again, and you can never regain what you have lost."—The Maritime World.

ON THE PRESERVATION OF UNFERMENTED GRAPE JUICE.

IT may be accepted as a certainty that prehistoric man, as he collected and ate the grapes growing wild about him, soon learned to prize the juice expressed from them as a most delicious potion and a highly refreshing beverage.

When, however, the hoarded stores of the grape juice or must began of itself to ferment and acidulate, he cast about for some means to preserve the juice in its pristine flavor and sweetness, and hit upon by accident, as it were, the first primitive beginnings of wine making. The discovery of that new alcoholic product, wine, resultant from the fermentation of the juice of the grape, without doubt gave a mighty impulse to the cultivation of the vine for the avowed purpose of obtaining from its rich clusters this exhilarating beverage.

Highly prized as were the grapes and the delightfully sweet must freshly pressed from them, yet the full enjoyment of their attendant pleasure was unfortunately limited to the season of the ripening fruit, for primitive man, even if he so desired, was not then equipped with either the knowledge or the utensils for preventing the spontaneous fermentation which ensues in a very short time.

However, with such an attraction it may not be doubted that very early in the life of the human race many and varied essays were made to keep the must in its original sweet and unfermented condition; among the easiest methods seems to have been that of condensing it by boiling. Such was indeed the custom of the period of later antiquity in Greece and Italy where the must was thus reduced to one-half, yea to one-third, of its original volume, to a thick syrup, as a means to its preservation for future use.

Ancient history relates that must thus condensed, when thinned again with water, not only supplied a most refreshing drink, but was also extensively used in the culinary arts. Its chief application, however, disclosed the intensely business qualifications of the ancient wine makers; for whenever a succeeding harvest of grape juice proved poor in sugar, by the addition of this condensed must, it was brought up to its proper saccharine standard. Boiling the grape juice down is practised in certain localities at the present day. In the closing years of the middle ages and those that followed thereupon, most singular expedients were resorted to to preserve the must sweet and tasteful, without other results, however, than to partially prevent fermentation or delay it, whereby tolerably successful samples of sweet and aromatic wines were produced. The most successful of these operations was the making of stum by the addition of sulphur or ground mustard-seed, a process pursued even now in certain places. As time advanced, and the various wine manufacturers became better acquainted with the cause of the fermentation, as well as with the many different modes of arresting it, the preservation of must upon a very extensive scale was again undertaken. However, since either the antiferments then in use did not possess sufficient stability to restrain, for any great length of time, the natural tendency to change in the juices, or because of the deleterious effects upon the health of the consumers, produced by excessive sulphuring or the employment of such reagents as salicylic acid, boracic acid, or any one of the many compounds of fluorine, the processes never seem to have attained to much, if any, practical value. Much more successful seem to have been the methods, the underlying principles of which were the annihilation, by means of heat, of the bacteria which produced the fermentation, in other words, the sterilization of the must—a process which received its greatest impulse from the experimental studies and more complete works of the now famous French scientist, Pasteur.

Very soon after Pasteur with his theories and experiments came upon the scene, processes embodying his principles were adapted to the making of wine, namely, the heating of the wine, now universally known as pasteurizing, to prevent the after-fermentation; and it proved to be but one step further in advance to apply the same procedure to the preservation of the freshly expressed must, thus checking at the outset all inclination on the part of the juice to change its constituent parts or alter their chemical combination. Not so long ago, in fact in 1877, among others a certain wine dealer in Mayence placed upon the European market a must which had been subjected to heat and highly recommended it as a medicine and a substitute for the grape cure then *en vogue*. It is not denied that the sterilizing of grape must by heat was practised in the chemical laboratories in order to preserve it in its unfermented state for later experiments and examination; it is rather conceded that such was the case, yet it was done in too small quantities to have any practical significance, certainly none whatever from a commercial viewpoint. Not until 1892 did the world possess a really reliable commercial process. In that year the prominent oenologist, the secretary of the *Associazioni vinicola e viticola dei Trentino*, Baron John a-Prato, after searching study and innumerable experiments, announced his system of filtering and pasteurizing the grape must.

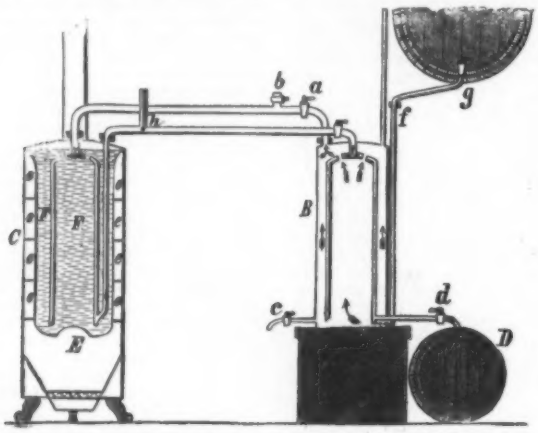


FIG. 1.—PASTEURIZING APPARATUS OF NEUKOMM (LONGITUDINAL SECTION).

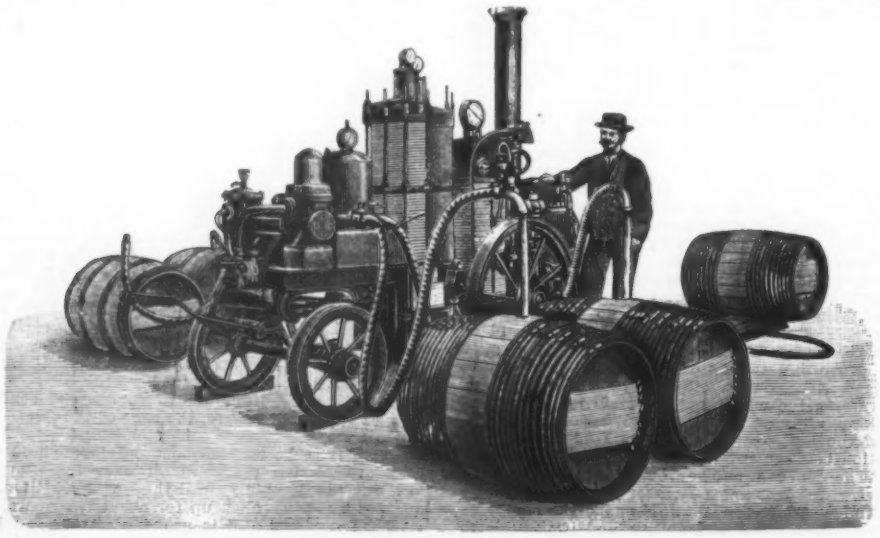


FIG. 2.—"PASTOR" STERILIZER OF MALVEZIN.

Recognizing the practical value of grape juice preserved in this manner for medicinal purposes as well as for purposes of pleasurable enjoyment, in 1893 he took out letters-patent upon the process in all the different countries likely to appreciate its worth.

In the summer of the year following, at the Universal Exposition at Milan, a-Prato exhibited some must from the harvest of 1893; the brothers Tavara, of Mazzara de Vallo in Sicily, also had an exhibit under the brand "*Mosto di Salute*," prepared under the a-Prato patents, both of which preparations were awarded premiums.

Samples of a-Prato's must were analyzed in the experimental stations at San Michele on the Etch, at Klosterneuburg near Vienna, at Geisenheim on the Rhine, and at the chemical laboratory of the city of Zurich, Switzerland, and reported favorably.

Many of the prominent physicians and professors attested its hygienic properties and special adaptability to use in certain diseases. Thus we see that for the preservation of an unadulterated grape-must in a rational and suitable manner we are indebted to the progress made in the closing years of the nineteenth century, since only within the last year or two has the manufacturer been assured of its practical accomplishment. Of grape-must in its condensed form the same may be said, for although from the earliest times the juice has been boiled to free it from an excess of water, a process which has been followed under varying conditions and in varied appliances with more or less success through the ages, yet only within the most recent times has it been achieved in a manner which leaves behind no taste of the boiling.

FIG. 3.—PORTABLE BOILER FOR STEAMING CASKS.

To Italy we are indebted for its first treatment *in vacuo*. Mussi, an inventor of Milan, exhibited at the International Exposition for machines pertaining to the culture of the grape and the making of wine, held in the city of Correggiano in 1881, an apparatus for the concentration of grape-must *in vacuo*, which was tried at the time and found measurably successful. More recently, in France, at a time when an overproduction of wine caused the growers to seek ways and means for adding value to their superfluous product, the question of concentrated must again came up, when the growers' attention was more especially directed to attempts to make a serviceable, perhaps better said drinkable, wine from the lighter musts, viz., those poor in sugar and acids, by concentrating and fermenting them. At that time stress was laid upon the conceit that in the production of concentrated must, it should not be done with the intention of using it exclusively for the building up of wines, but rather that the condensed or evaporated must should itself become an article of commerce and provide means for producing the so-called non-alcoholic beverages.

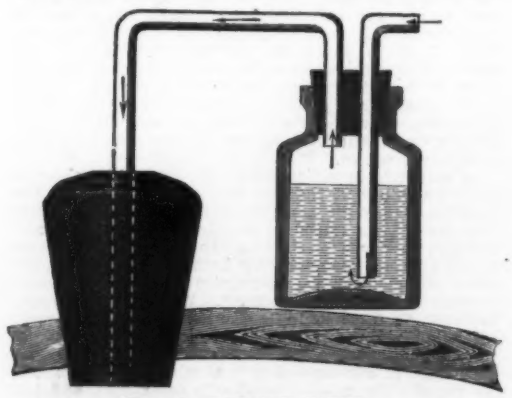


FIG. 4.—SAFETY BUNG.

While up to the present the preparation of concentrated grape-must has not reached large proportions, it may nevertheless be expected that this method of rendering a product of the vine commercially available will receive especial attention from the growers whenever they are again confronted with the question of a profitable disposition of an enormous surplus.

In any case, it must be conceded that only upon an extensive scale, by means of the most approved ap-

pliances and under the management of an expert oenologist, at the same time being assured of a good market, can this industry be carried forward with any certainty of success.

Grape-must is the fresh juice of the grapes as it runs from the press. This must, therefore, contains not only all the soluble parts of the grape but, depending upon the amount of care exercised in its preparation, also other substances which get into it by accident, such as the impurities adhering to the outside of the skin, some of the grape pulp, parts of the skins and seeds. If it be eminently necessary to

FIG. 5.—"KEIMTOETER" (GERM KILLER) SAFETY BUNG.

preserve from all possible impurities the must which is intended for the manufacture of wine, it is more indispensably requisite that every imperfection should be eliminated from the must which is to be preserved in its unfermented state. For this reason, therefore, only clean, sound, faultless grapes must be selected and all sickly, rotten, moldy or dirty grapes must be carefully culled out to obtain the must in the purest possible condition. In order to obtain the most complete returns from the grapes, they must first be crushed and the mash thus formed subjected to pressure. No uniform method was followed in the beginning, in any of the wine growing countries.

FIG. 6. FIG. 7. FIG. 8.

Fig. 6.—Asbestos filter elements (parts). Fig. 7.—Asbestos filter elements (assembled). Fig. 8.—Holland filter with asbestos filter elements.

The first and most imperfect process is no doubt the treading out with the bared feet or feet shod with specially constructed boots or wooden sandals; in some of the districts situated far from commercial centers, this process is, to some extent, still in use. In other provinces the grapes are crushed in a huge vat with large wooden pestles, a cleaner process indeed, but still imperfect.

The most complete and rational mode of crushing, and the one used at present in all establishments where up-to-date processes are employed, is a well-made grape mill. Any number of such mills are on the market, some of which confine their usefulness to the mere crushing of the luscious fruit, while others, in addition, remove the rape or stems and stalks. Being left to itself in ordinary temperatures, the fresh must suffers in a short time, a remarkable change. Originally clear, the must will soon show signs of clouding up, small air bubbles begin to form and ascend, at first but slowly, but later more rapidly, and finally cause a decided foaming.

During this action the temperature of the liquid itself is raised, and the former sweet taste gradually grows less or disappears altogether, to be succeeded by a pronounced wine-like taste accompanied by a peculiar smell of spirits. This characteristic process is known as fermentation, and is the immediate result of the chemical change in the sugar contained in the must, which gives off two elements not present before, viz., alcohol or spirit of wine and carbonic acid. The alcohol remains in solution, while the carbonic acid in the form of a gas for the most part ascends in the shape of bubbles to the surface and escapes. It is this more or less rapid movement of the gas bubbles which causes the foaming.

This mode of chemical change or fermentation in

FIG. 10.—CORKING MACHINE WITH SEAT.

liquids containing sugar whereby not only carbonic acid is freed but alcohol is the chief product, is called the alcohol or wine fermentation, and upon it depend the principles of wine making.

Should it be determined to prevent the fermentation of grape-must, the first thing to decide upon is whether the delay shall extend over a short time or for an indefinite period. In the former case, it is only necessary either to counteract the conditions which permit of the growth of the fermentation bacteria, or to remove a part of them or cause some of them to be killed; either process will result in a temporary delay. But if it is the intention to preserve the must indefinitely in its sweet condition, every trace even of the fermentation bacteria must be removed. The means in use for delaying fermentation may be divided into three classes, viz., such as operate mechanically, in separating the bacteria, or such as produce a physical effect upon the germs, and finally such as employ chemical reagents.

Fining and filtering may be regarded as the mechanical means generally employed, though the results are far from perfect or lasting, for they remove only the greater part of the fermentation bacteria. A sufficient number always seem to escape to propagate their species further and eventually accomplish the change. A more certain method is the one known as the physical process, which consists in raising the temperature of the liquid beyond that point where the fermentation bacteria thrive or can develop.

If this temperature is sustained for any length of time, not only are the microbes present killed off, but a certain condensing of the saccharine contents of the must ensues, which renders further development of noxious bacteria impossible.

Under the name "chemical group" are known those processes which preserve the grape-must and other

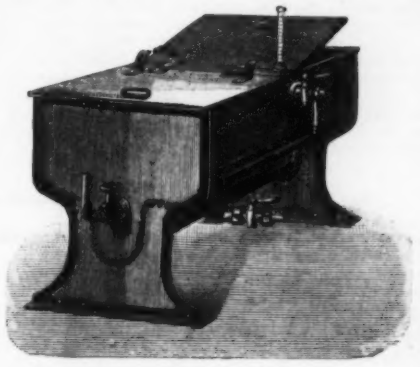


FIG. 11.—BOTTLE PASTEURIZING APPARATUS WITH STEAM HEAT.

fruit flavors by the action of added chemical reagents, which accomplish the result partly by killing all bacteria present, and partly by so changing the chemical combination of the contents that all further alteration is prevented.

Although there are innumerable substances which, if added to the must of the grape or other fruits, will destroy the bacteria that contribute mainly to the fermentation or acidulation of the same, yet since these beverages are to be imbibed by man, not only must due consideration for the health of the consumer be taken into account, which admits the use only of such agents as produce no deleterious effects

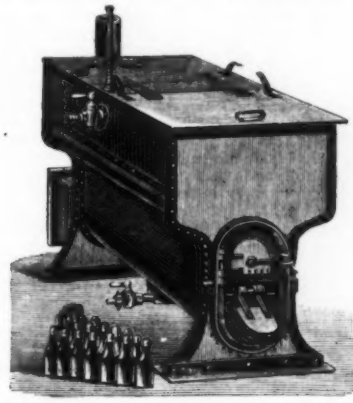


FIG. 12.—BOTTLE PASTEURIZING APPARATUS FOR DIRECT FIRING.

upon his well-being, but a strict conformity must also be exercised to the laws regulating the preparation of foodstuffs. Even of these permitted preservatives, their employment is restricted according to the purposes for which the must or flavoring extracts are intended. Among this group of chemical preservatives then only are alcohol, sugar, sulphurous acid, and mustard meal; the use of this latter being especially closely watched. Alcohol of sufficient strength will destroy all the fermentation bacteria or any cognate organisms and form an effective preservative. If it be desired to preserve the must in its sweet and unattenuated condition on a small scale, say for family use, it would be out of the question to provide the apparatus and appliances used in the factories, yet the small producer must proceed upon the same basic principles; for him, therefore, the heating or sterilizing of the must is the most practicable. The most

FIG. 9.—AUTOMATIC BOTTLE-FILLING BATTERY.

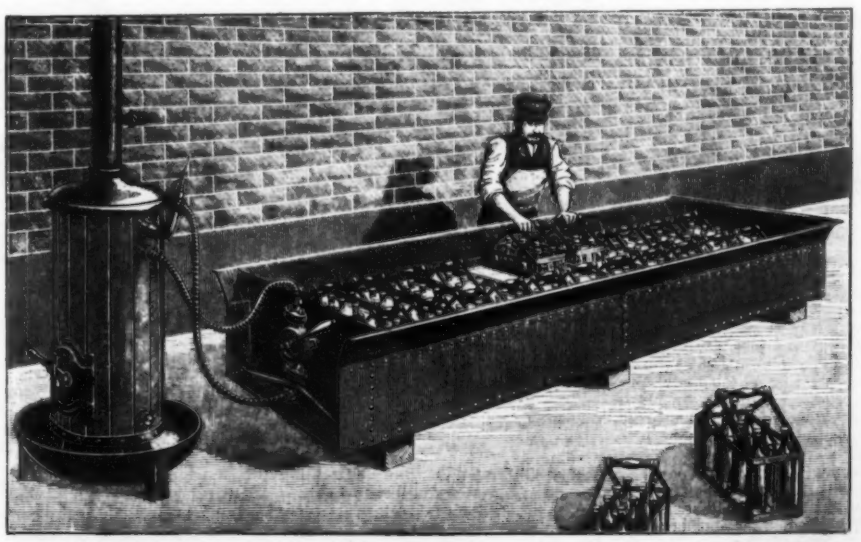


FIG. 13.—PASTEURIZING APPARATUS OF GASQUET FOR BOTTLE WINES.

approved method consists in taking the juice direct from the press before the least trace of fermentation can have made its appearance and passing it through a medium fine hair sieve to remove all the solid particles. It would be of advantage after this to filter it through a sack made of white flannel thick and well shrunk, previously wet with water, in order to purify and clarify it further.

This should now be run into perfectly clean bottles and immediately corked and sealed. The bottles should not be filled entirely, for, during the heating or sterilizing the must expands and room must be left to accommodate this increase. It is advisable to subject the bottles, immediately after filling, to the hot water bath, which may be done in any large pot or pan. If the operation were to be done on a considerable scale, it would be better to provide a long

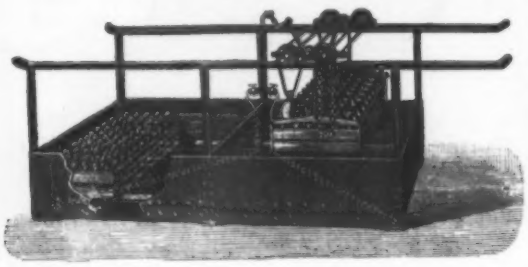


FIG. 14.—BOTTLE-PASTEURIZING APPARATUS.

trough-like boiler; and, in order to avoid standing them direct on the bottom, which, by being unevenly heated, or from the violent ebullition of the water, may result in some breakages, it is better to construct a perforated false-bottom to sustain the bottles and place it about 4 inches above the bottom proper; a good substitute for a perforated bottom is a thick layer of excelsior, upon which the bottles may stand upright while the same material may be inserted between them to prevent their toppling over and breaking. Having packed the bottles in the trough in this manner, fill up with water until the bottles are wholly submerged and then apply the heat, raising the temperature slowly till the thermometer shows from 50 deg. to 55 deg. R. (149-158 deg. F.) To save time, the trough might be filled with water previously raised to 30 deg. R. (100 deg. F.) This bath must be continued somewhat over half an hour at an even temperature by a close regulation of the fire in order to be sure that all the microbes have been killed. Having accomplished this part of the process, the fire may be drawn and the water allowed to cool down to 40 deg. R. (122 deg. F.) having previously drawn off sufficient to allow the necks or mouths of the bottles access to the air. As soon as the bottles and contents have cooled off, remove the binding twine or wire from the cork and cut the cork off even with the top of the bottle. To guard more thoroughly against any chance entry into the must, either through the cork itself or possibly between the cork and the neck of the bottle, it is advisable, having first carefully wiped off both neck and cork with a cloth saturated in spirit of wine, to seal the opening either with fluid bottle lacquer or better yet some melted paraffine. Must sterilized in this manner is sure to keep fresh and sweet, since all the fermentative spores have been annihilated, yet by reason of the albuminoids and proteids contained in the juice of the grape which have coagulated during the application of the heat and become separated the liquor will become more or less cloudy. After a time these semi-solid bodies precipitate. To obtain this result most perfectly, the bottles should be laid away—piled up on their sides, not stood on the bottoms—in a cool, dry place and allowed to remain untouched for several weeks. It now becomes necessary, especially if the product has been made for sale, to open the bottles and remove by filtration all such deposits. The bottles are now taken in and given a shaking to remove the sediment from the walls of the bottle and placed upright for a few days until the sediment is again deposited, this time on the bottom.

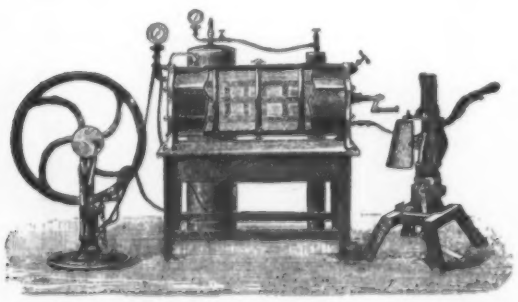


FIG. 15.—SPARKLING-WINE APPARATUS FOR LIQUID CARBONIC ACID.

As soon as the must again appears clear, the bottles are opened, the clear liquid being carefully poured off into a filter; when the cloudy portion is reached, this should be placed by itself in a demijohn or other receptacle to be filtered later. Since, through the consequent exposure of the must to the air, the minute and dangerous fermentative spores have again an opportunity to find lodgment in the must, it becomes necessary to resterilize the bottled must in the same manner as before with the same apparatus and the same heat values. Whether large or small quantities are considered, the principles of sterilizing and the method of procedure remain unaltered, it is merely a question of the size of the apparatus needed. To achieve satisfactory results the same steps must be taken and in the same order. In selecting an apparatus for sterilizing the must, care must be had that, in the warming of the must, not only are all the fermentative microbes killed, but that the albuminous bodies coagulate and deposit to a great extent in the tank or trough used. Such an apparatus must be so constructed that all the surfaces which come in contact with the must may be readily got at and easily cleansed. Furthermore, means must be provided for regulating the temperature during the operation. Must, even to a less degree than wine, should not be heated over a direct fire, but either in a water or steam bath, for must absorbs much easier than wine a taste of cooking, if heated over a direct fire. All parts of the apparatus exposed to the action of the must require perfect timing to avoid any contact with lead. Should it be convenient to pasteurize the must in an apparatus for sterilizing wine, it must not be overlooked that must requires a higher temperature than wine, because not only must the fermentative microbes be destroyed, but also those spores which produce mold and which not only require greater heat to exterminate them, but a considerably longer exposure to that heat. With the observance of these important differences, then all well constructed wine warmers may be used for the sterilizing of must.

An apparatus especially adapted for the sterilization of must and called by its inventor's name, "The Neukomm," is shown in Fig. 1, which gives its internal arrangement in cross section. *E* is a stove in which is placed a kettle, *F*, filled with water; *e*, *e*, *e* space between outer and inner walls for combustion of gases from fire on grate below. Through a system of pipes submerged in the heated water, the must is made to circulate by gravity in a direction indicated by the arrows. On the pediment to the right is also a warmer, *B*, from which after the operation the contents are drawn off at *C*. Another invention for this purpose called the "Pastor," constructed by Malvezin, is shown in Fig. 2. Its interior construction is such that it may be readily cleansed, a most important feature in everything connected with must. Must sterilized with such machines should not be immediately bottled, because time must be given for the precipitation of the insoluble particles. Again, there would not be sufficient time to do the work during the harvesting and pressing season. The grape juice must therefore be run off into large tuns or casks and stored away to settle till such time as it may be convenient to bottle it. For storage, either wooden tuns, glass, or earthenware demijohns will serve. If casks are used, care must be observed that they are well wine-seasoned and by a thorough steaming freed from all impurities due to the wood. A portable boiler is best adapted for this steaming-out process, though any other means of making steam under a medium pressure may be employed. We give in Fig. 3 a portable boiler with attending requisites, which is in high favor among the makers of sterilized must and wine. The casks having been well steamed and thoroughly hot are filled at once from the sterilizer up to the bung hole. To prevent the entrance of the noxious spores, which it has cost so much trouble to eliminate, the sealing of the bung must be accomplished with great care, and as in the case of the bottles, it may be done in various ways.

A simple arrangement for this purpose is exhibited in Fig. 4. It consists of a heavy soft rubber bung pierced through its center, through which is passed a tight fitting hard rubber tube bent in such a manner that it may reach and pass through a second soft rubber cork into a wide necked bottle containing high grade spirit of wine. It will be seen that the pipe just passes through the cork in the bottle, stopping just above the surface of the spirit. A second, and this time a glass tube, pierces the cork of the flask and from beneath the surface of the spirit communicates with the outer air. The *modus operandi* is easily understood. As the must cools and the cask cools, a condensation ensues which produces a vacuum, which in turn is naturally filled by the surrounding air. As arranged, the air may find ready ingress, but by so doing it must pass through the spirit of wine in the flask which relieves it of all the noxious infusoria or micro-organisms.

A cask which has been steamed out, but not filled for want of material, if provided with such an apparatus may stand some time without danger of being affected. If it be desirable to fill such a cask without resteaming, it only remains to connect the hose with the lower or draft hole, and by removing the short tube from the flask and lowering the short end of the hard rubber tube till its mouth is sealed by the spirit of wine the must may be pumped in or run in by gravity while the escaping air finds its exit through the spirit which effectually seals it against any return. In Fig. 5 we are able to show another means of effecting the same thing. It is called the "germ killer." It is made of glass with a metal cover, its lower extremity being of conically ground glass, which is driven into the bung hole by turning or twisting it, and any possible crevices between it and the wooden hole sealed with soft cement to insure an absolutely airtight joint. Air may now enter the cask only through this apparatus, which, in much the same manner as the one just considered, is provided with a seal of spirit of wine. It may be readily cleansed, and, since it is adapted for a reversal of the course of the air, it may be equally as readily used for filling the cask. Possessing as it does the natural tendency to clarify itself after standing some time in store, the preserved must may, when required, be filled direct

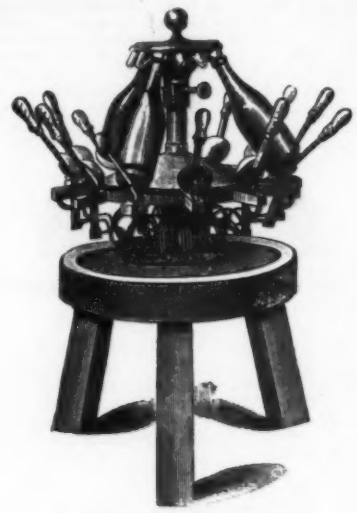


FIG. 16.—TOURNIQUET.

from the casks into the bottles, and only in cases where it is not quite clear will it be necessary to filter it and of course repeat the sterilizing process. Of course in filtering the must, which has been allowed time to precipitate its semi-solid substances, there is not so much likelihood of clogging the filter as is the case with freshly pressed must. Of the many varieties of filters in use, and on the market the asbestos filter seems the most serviceable for filtering the settled must; it consists of layers of specially prepared asbestos. The construction of such a filter is shown in Fig. 6; it is made up of a long, narrow cylinder, closed at both ends, the walls of which are of well tinned woven copper wire—a copper sieve, in fact—a screw-threaded ¾-inch opening on top and a 2-inch emptying cap on the bottom. Outside of this sieve is another protecting sieve woven of copper bronze wire. The filling tube shown separately, and in Fig. 7 in place, extends nearly to the bottom of the elongated sieve and is only removed when the filter is to be cleaned. These filters, if more than one are used, are fastened on the bottom of the vat containing the must or wine to be filtered, as shown in Fig. 8, directly above the cask or vat to contain the filtered product.

To start the operation, it is necessary to mix up the asbestos with some of the must and pass it through the filter; in its passage it carries the fine asbestos along and deposits it as a thin film, evenly distributed, over the inner surface of the sieve, which forms a most perfect filter for the rest of the liquid. These filter-units possess the added advantage that they are readily adapted to the older-fashioned Holland filter, as we show in Fig. 8. Should the preserved must in the casks have become so clear that it may be filled into bottles without filtering, a bottle-filling machine is the next requisite, and the one found most practicable for this purpose is the automatic filling machine or battery shown in Fig. 9, which by means of a rubber hose is connected direct with the spigot of the cask. This battery may be readily attached to the tapping cock of the filter if it be necessary to filter the must.

FIG. 17.—SPARKLING-WINE APPARATUS FOR IMPREGNATION IN THE BOTTLES.

Being thus filled the bottles must be corked, and for this purpose we show in Fig. 10 one of the most approved appliances. Re-sterilizing is now in order for reasons detailed above, and it is scarcely necessary to add that the greatest possible care must be taken to have everything perfectly clean, for upon this one circumstance depend the lasting properties of the product. The manufacture of preserved or pasteurized must on a large scale presupposes the incessant sterilizing of thousands of bottles. The ordinary troughs used in sterilizing the beer bottles, which we show in Figs. 11 and 12, will answer the purpose very well. Fig. 11 gives us a view of a bottle sterilizer in which steam is exclusively used for heating the water, and it is so constructed that the steam enters water surrounding the bottles without the usual noise accom-

panying it. The apparatus shown in Fig. 12 is arranged for a fire directly under the water. Both these covered tanks are constructed with a circulating water chamber and differ only in the means of heating the water; a method of forcing the circulation is also provided.

Having attained the desired temperature and retained the bottles in it for the required time, the process of cooling is begun either by turning off the steam supply or drawing the fire; admitting cold water into the circulating chamber and allowing the warm water thus displaced to flow away hastens the cooling. These sterilizing tanks are also arranged for heating by gas, and they are made in eight different sizes with capacities from 50 to 1,250 bottles holding 0.7 of a liter each. Practice shows that two such troughs are better than one large one, for they afford a means of uninterrupted work, since one may be heating while the other is cooling, in which manner each may be filled several times a day. A simpler apparatus and one better adapted to the sterilization of must in bottles is the one shown in Fig. 13 made by Gasquet. This apparatus is intended for continuous work, and, as may be seen by consulting the cut, consists of a large trough divided into twelve compartments or cells. The partition walls are perforated so that the water may circulate freely through them, and each cell is large enough to contain an iron skeleton basket which will hold from eight to twelve bottles, so that a trough of this kind and size will sterilize from 192 to 288 bottles at one time. A small steamer connected by wire-wound rubber hose to the trough furnishes the heat, and a water pump on one side or end provides for the circulation. Somewhat similar to the one just described is a trough shown in Fig. 14. Its construction differs materially only in that it handles larger baskets of bottles; each basket contains fifty bottles, which, being too heavy for one man, are raised and lowered by tackle and run along from place to place upon rails. The heating and cooling of the sterilizing water is effected in much the same manner, except that since the trough is divided into two compartments which are not intimately connected, it really forms two sterilizing troughs which may be worked independently. Must treated in this way may be kept indefinitely in bottles, provided the bottles are stored in a horizontal position, for if the bottles stand on their bottoms, having been closed with ordinary bark corks, the corks will dry out in time and shrink away from the neck of the bottle, thus admitting air, and the mold-spores will pass in and spoil the must. In the same manner that artificial effervescing wines or champagnes are made by impregnating them with carbonic acid gas pumped into the bottles, effervescing or sparkling must may be manufactured, and it makes a particularly refreshing beverage. Carbonated must is made in one of two ways, being impregnated with the carbonic acid gas in the usual machines for that purpose and drawn into bottles and sealed or saturated with the gas after being bottled by means of the usual appliances, well known to all bottlers. All bottles containing carbonated must should of necessity be tightly corked and the same secured by the use of strong cord or wire. Since considerable quantities of carbonic acid are lost in either of these processes, it has become necessary to invent some contrivance which will effect a saving in this particular field. We show in Fig. 15 an apparatus designed for the use of liquid carbonic acid gas. Here on a table is a mixing cylinder, the outer walls of which have been cut away to show the interior mixer of glass in which a dash wheel is made to turn by means of the crank seen at the right. The outer or protecting cylinder, of sheet copper well tinned, is intended to resist the pressure of the gas and relieve the glass or real mixing drum from undue strain. Just behind the table to the extreme right of the picture stands the flask containing the liquefied carbonic acid gas; it is connected by means of a copper tube with an expansion cylinder also visible on the left, which carries a pressure gage and safety valve. Through another copper tube this is connected with the mixer. The double acting compressor on the extreme left is intended to return any surplus carbonic acid gas to the expansion cylinder when the mixer is about to be emptied; or when the liquefied gas has become exhausted to such an extent that the desired pressure is no more present it may be used to pump direct from the gas cylinder into the mixer, in this manner saving every foot of the gas. Of course, in smaller plants both the expansion cylinder and the pump are wanting and a simple reduction valve takes their place, which easily shows where and how the loss of gas is made. A corking machine, shown also in the cut, is connected directly with the mixer. The carbonating is accomplished similarly to the method pursued with wine. The mixer is filled to overflowing to expel the air, then closed, connected with the gas tank and about 5 per cent of the contents blown out, which is replaced by the gas, of course. The tap is now closed and the remaining must subjected to the pressure and mixing until it becomes saturated with the gas. Almost any of the many appliances used nowadays for the making of artificially effervescent wines direct in the bottles will do the same for the must. They are usually so constructed that the mouth of the bottle is hermetically closed by a hollow rubber cork, through which the carbonic acid gas may be introduced. The bottles are kept in motion to facilitate the mixing of the gas and must, and when the desired quantity has been absorbed, removed and corked. Fig. 16, the "Tourniquet," shows a machine, the object of which is to close and hold the filled bottles until the foaming has ceased sufficiently to allow of corking them permanently. In Fig. 17 we show a machine invented by a Mr. Bartelt, so contrived that twenty bottles of wine or must may be carbonated at the same time direct from the flask. The bottles are fastened by screws into the frame with their necks pressed over mouth-pieces issuing from a central pipe, which serves at once as a conductor for the gas and an axis of revolution about which the bottles are made to turn by means of the hand wheel on its outer extremity, which keeps the must in a state of agitation and facilitates the absorption of the gas. We repeat, all bottles of must ought to be resterilized immediately after being corked, and those bottles which have been carbonated must be stored upon their sides to prevent the corks from drying and shrinking and a consequent entrance of air and fermentative bacteria.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Der Stein der Weisen.

WOLFGANG VON KEMPELEN'S TALKING MACHINE.

IN very distinct episodes the history of the "lower" mechanics teaches us how greatly the reward for ingenious inventions is subject to the changeable whim of the great public, who will to-day idolize the clever maker of a technical masterpiece, to forget him tomorrow over new problems. Verily the rubbish heap of the history of inventions, from which we take an object, could tell touching stories of brilliant momentary successes and a rapid fall into the depths of oblivion.

One of the most interesting mechanical curiosities, whose exhibition in the beginning of the nineteenth century created no little stir at the courts of Europe, was the talking machine of Wolfgang von Kempelen.

Among chess players the Pressburg builder is well known as the ingenious constructor of an automaton in the shape of a Turk, who played chess like a live person with any opponent, and caused a great sensation, owing to the secret of his construction.

When Kempelen in the same year, 1769, that his automatic chess player started on his triumphal tour through the civilized world, occupied himself with physiologico-acoustic problems, directing his attention especially to the idea of a mechanical reproduction of articulate sounds, the construction of an ingenious mechanism was suggested to him by the sight of a simple bagpipe, a construction which by the employment of a suitable keyboard could be changed into a "phonograph," or, better still, a "speaking organ."

Kempelen described the apparatus in a learned work entitled "Mechanismus der menschlichen Sprache" (Mechanism of Human Speech), Vienna, 1791, which is interesting reading even to-day, although the hypotheses of the author must be rejected as groundless and partly absurd. According to an accompanying copper print, the construction resembled an old-style harmonium. The mouth pieces of the pipes were formed by longish boxes of wood which were divided into two "jaws" (sound boards). The lower end was united to the upper one by a leather hinge. In order to regulate the size of the opening between the two jaws exactly—this was the chief essential for the production of the tones—a gut string was attached to the lower bottom of each mouth piece, which was drawn through a hole of the upper "jaw" part and connected with the keyboard. Each letter had its own key—similar to the keyboard of the first electric telegraph apparatus of Sömmering. This key system, it is true, produced the disadvantage that the letters were heard in rotation in a chopped-off manner; thus "Papa" sounded like P-a-p-a.

In order to obviate this grave drawback, Kempelen undertook a radical alteration of his speaking machine, which he successfully accomplished after two years. The apparatus thus improved was considerably more complicated. A sound pipe was shoved into the opening of the wind chest while the tongue was made of a thin leaf of ivory. To the ivory leaf a wire was attached, which commenced to vibrate when it was struck by a gust of air through the sound pipe; the tone reinforced by reflection resembled a pronounced "r." As regards the rest, the organ-pipe system was retained, only that by observing the vibration-phenomenon an abrupt ejection of the different letters was avoided.

The inventor said: "A remarkable perfection in playing may be attained in three weeks, especially if the Latin, French or Italian language is used."

This remark of the builder would indicate that the aspirants and sibilants, in which the Northern languages abound, were but imperfectly reproduced by the "talking machine." The small size of the bellows, which had to send the necessary wind into the sound pipes, made the rendering of long sentences impossible. The arrangement of the "mouth"—consisting of a bottle of elastic rubber connected in a suitable manner with resonance plates—was found to be very awkward.

Nevertheless, we soon find the "phonograph"—like the chess-playing Turk—on its triumphal march through the civilized world. It was last seen in 1827 in Berlin, where it formed the chief attraction of a dubious exposition. After that, Kempelen's "talking machine" disappeared entirely.

Although no "resurrection"* will fall to its lot, it is nevertheless interesting and gratifying to note by what laborious efforts aspiring minds of the recent past have endeavored to break a way for the dominion of man over the principal laws of nature.*—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Prometheus.

FLY-WHEEL AND BOILER EXPLOSIONS COMPARED—SPEEDS FOR CAST-IRON WHEELS.†

By WILLIAM H. BOEHM, M. Am. Soc. M. E.

THE influences that bring about fly-wheel explosions are in some respects very similar to those that produce boiler explosions.

In the case of boilers *steam* exerts a radial force acting on the shell of the boiler, and whenever the steam pressure, either through accident or negligence, increases sufficiently, the radial force bursts the shell with great violence. In the case of fly-wheels *speed* exerts a radial force acting on the rim of the wheel, and whenever the speed, either through accident or negligence, increases sufficiently, the radial force bursts the rim with great violence.

In both cases the direction of the forces is the same, since they both act from the center toward the circumference. In the case of boilers steam exerts the radial force that produces an explosion. In the case of fly-wheels speed exerts the radial (centrifugal) force that produces an explosion.

These influences are widely dissimilar in other respects.

In the case of boilers the force tending to burst the shell increases directly with the steam pressure. Doubling the steam pressure, for example, doubles the force acting on the shell. In the case of fly-wheels the force tending to burst the rim increases with the *square* of the speed. Doubling the speed, for example, quadruples the force acting on the rim.

In the case of boilers their strength may be increased by increasing the thickness of the shell. If we double the thickness of the shell, for example, we double the strength of the boiler. In the case of fly-wheels increasing the thickness of the rim does not increase the strength of the wheel, because the weight thus added also increases the centrifugal force, leaving the wheel no stronger than before.

Fly-wheels are intended primarily to prevent sudden fluctuations of speed, although they usually carry a belt and thus serve as a driving wheel as well as a fly-wheel. Their capacity to regulate speed fluctuation depends upon their weight and speed. If, for example, we should double the speed of a wheel, we would require only half as much weight to secure equally efficient speed regulation. Inasmuch as the cost of a wheel depends directly upon its weight, it is common practice to run fly-wheels at the highest possible speed in order to save weight and economize in cost.

What then is the highest speed at which fly-wheels may be run with safety? Evidently there is a *danger limit* for every wheel regardless of the amount of material it contains. For wheels made in sections this limit depends upon the efficiency of the rim joints as well as upon the kind of material of the wheel.

In a previous article we gave the limit of rim speed for wheels made of cast-iron, steel and hard maple. For cast-iron wheels as ordinarily constructed a rim speed of a mile a minute was shown to be the limit for safety, and we now give a table stating the number of revolutions per minute for cast-iron wheels, from one foot to thirty feet in diameter, at which the danger limit is reached. This table will be useful in indicating whether or not a wheel of given diameter is revolving at dangerous speed.

SPEEDS FOR CAST-IRON WHEELS.

Table giving the number of revolutions per minute at which the rim speed for cast-iron wheels reaches the danger limit of one mile per minute.

Diameter of wheel in feet.	Danger limit, revolutions per minute.	Diameter of wheel in feet.	Danger limit, revolutions per minute.
1	1680	15½	108
1¼	1344	16	105
1½	1120	16½	102
2	840	17	99
2½	672	17½	96
3	560	18	93
3½	480	18½	91
4	420	19	89
4½	373	19½	86
5	336	20	84
5½	305	20½	82
6	280	21	80
6½	258	21½	78
7	240	22	76
7½	224	22½	74
8	210	23	73
8½	198	23½	72
9	187	24	70
9½	177	24½	68
10	168	25	67
10½	160	25½	66
11	153	26	65
11½	146	26½	63
12	140	27	62
12½	134	27½	61
13	129	28	60
13½	124	28½	59
14	120	29	58
14½	116	29½	57
15	112	30	56

IMPROVEMENTS IN GAS ENGINES.

SOME interesting information relative to recent improvements in the gas engine has been published by Prof. Hudson Beare, of Great Britain. One of the most important improvements in this connection was the solution of the gas producer problem by Mr. Dowson and Dr. Mond. In Dr. Mond's system, which is perhaps the most successful on a large scale, the cheapest of fuels can be used, and without adding greatly to the capital cost, or the expense of working, ammonia recovery plant can be employed along with the producer. The principal difference between this system and others is in the large quantity of steam, which is mixed with the air and blown into the producer, the weight of steam decomposed per ton of slack being about half a ton, and the final producer gas contains about 29 per cent of free hydrogen. One of the secrets of the great success of this producer is the elaborate care which has been taken to utilize the regenerator principle at every stage of the process. A medium-sized producer can deal with twenty tons of slack per twenty-four hours, producing a little over 3,000,000 cubic feet of gas, of a calorific value of about 148 British thermal units per cubic foot; and if the supplementary steam can be obtained by utilizing waste heat, as is done in some of the plants, about 84 per cent of the original heat of the slack is obtained in the gas produced. The question of the utilization of blast furnace gases for working gas engines dates back to 1894, and the first gas engine in Great Britain to use these gases was a small "Acme" engine fitted up at the Glasgow Iron and Steel Works in 1895. In Belgium the Cockerill Company have done splendid work in developing this branch of engineering, and in Germany there has also been a great advance in the design and construction of large engines suitable for use with this gas. The greatest difficulty has been the removal from the waste gases of the dust carried out from the blast furnaces; but by the use of a centrifugal fan, into the

* For curiosity's sake it may be mentioned that Johann Joachim Becker's "Narrische Weisheit und weise Narrheit" (Foolish Wisdom and Wise Foolishness) edition of 1727, bears the following note on page 83: "I have known an organ builder, who though not a scholar had ingenious talents and has spent much time over the problem to express some letters artificially, as in speech; his organ pipes sang a large number of the letters of the A B C and reproduced them partly in a highly natural manner."

† From the Monthly Bulletin of the Fidelity and Casualty Company.

center of which a jet of water is fed, or by the use of sheet-iron towers containing coke or sawdust, which serve as scrubbers, this difficulty can be overcome. The heating value of blast-furnace gases ranges from about 105 British thermal units to about 115 per cubic foot, and it is estimated that about 22 per rapid development in the utilization of blast furnace are available for working gas engines. On this estimate it is calculated that in Germany, for example, where about 7,500,000 tons of pig are produced per annum, about half a million horse power can be obtained from the waste gases.

THE NEW OBSERVATION KITES INVENTED BY S. F. CODY.*

FOR some time past attempts have been made to devise kites of sufficient dimensions and lifting power to carry a person into the air, either for meteorological observations, or simply to reconnoiter the surrounding country, the latter object naturally constituting for the most part an acquisition to a military equipment. Major Baden Powell of the British army has devised a kite which will lift a man into the air, but its scope, as frequent experiments have shown, is somewhat limited. Mr. Samuel Franklin Cody, however, has devised an observation kite which has been submitted to several exacting tests in England, and has proved practical and successful for general observation and meteorological experiments.

The most salient characteristics of the Cody apparatus is that a greater weight can be lifted than has heretofore been possible; the facility and celerity with which the apparatus may be collapsed, packed away in a small compass for transport, and re-erected for use; and also the improved mechanical arrangements for controlling the movements of the kite while in the air and regulating both its ascent and descent. This latter action is accomplished by means of an ingenious brake or retarding device connected with the drum or mechanism, upon which the cord or wire attached to the kite is unwound or wound respectively.

As will be seen from the accompanying diagram (Fig. 1) a series of kites are attached to the main cable. The first kite (*a*) attached to the extreme end of the cable acts as a pilot, or initiatory kite to raise the series from the ground. Two or more kites, according to the weight to be lifted, atmospheric conditions, etc., are attached to this cable at predetermined intervals, and lastly comes the carrying or traveling kite (*d*) which can be attached to the main cable at any point as desired by means of a special controlling mechanism.

The kites are of an improved box type, consisting of double ends or cells separated by a central lattice work partition, thus giving the appearance of two box kites placed side by side. The united kites are connected by four stays or rods, the ends of which fit into sockets at each end of the cells, while each end is furthermore tied to the canvas. This latter arrangement dispenses with nails, tacks, or similar fastenings to secure the rods to the canvas. This framework of the double box is built up of hickory, aluminium, or some other similar light and flexible albeit rigid material, and is braced by means of diagonal stays at the ends, being held firmly in position by means of string-like cords passing from one to the other. These tightening members are arranged in pulley block form, *i.e.*, one cord passes over and around pulley-like surfaces, by which means a purchase is obtained when the free end of the cord is pulled by the hand. The interior cord attachment enables the four diagonal members to be extended until the desired degree of tension upon the four supports of the frame, when the latter are in position, is attained. To the upper edges of the duplex box, two large aeroplanes are attached, extending the full length of the frame, and two smaller aeroplanes are fitted to the bottom edges of the framework. The side aeroplanes are shaped so as to resemble as closely as possible, when distended, the wings of a bird. The bottom aeroplanes, on the other hand, are of triangular form, and their scope is principally to afford footrests for the kite when resting on the ground. On some of the kites Mr. Cody has arranged another aeroplane on top of the apparatus, this latter conforming somewhat with the shape of the body and head of a bird.

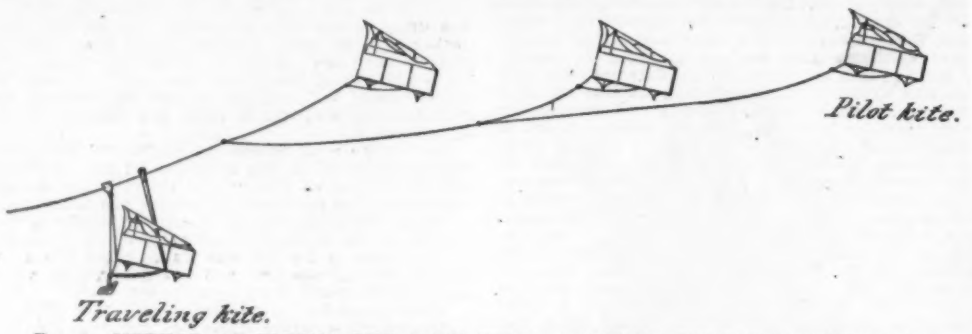


FIG. 1.—METHOD OF FLYING THE CODY KITES, SHOWING THE ATTACHMENT OF THE TRAVELING KITE.

The aeroplanes are built upon a rigid framework, the main or backbone stay as it were stretching diagonally from the top of the wing through holes in the box cells and terminating in the edges of the latter. The wings are further supported by transverse stays, thus affording a flat surface for the covering material, which is cut in slightly concave edges, so as to prevent flapping in the wind. The wings and framework of the box may be covered with any suitable material, such as silk, canvas, or thin aluminium sheeting as required, though it is desirable to employ light material, so that the kite may be of the minimum weight consistent with the maximum of strength. A rope bridle is fixed to the kite to attach the latter to either the main or an auxiliary cable. In the event of the last-named arrangement of flying from two lines, the pull of the kite is so controlled as to be evenly or otherwise distributed over the two lines or one, as desired. The bridle is composed of three ropes, two of which are attached to the two front outer or lower corners of the duplex box, with a rope stretching from the base of the center partition to the junction of the two side cords, and the three ropes are strongly secured in a splicing.

The basket or chair is suspended beneath the traveling kite. If necessary this kite can be made to travel backward or forward along the main cable, for which purpose two traveling pulley blocks are provided, and the kite carrying the basket or car is slung therefrom.

The drum upon which the cable is paid out and wound in resembles in appearance a gun carriage with trailer. At the extreme end of the trailer is a long pointed tooth, which is forced into the ground, and holds the carriage rigid while the kites are being flown, exerting a strong tension upon the cable; otherwise the volition of the kite would pull the winding drum along.

The feature of the drum is the braking apparatus, by which the winding and unwinding of the cable is controlled. This brake comprises a grooved pulley attached to the shaft of the winch. Round the latter is placed a brake belt consisting of a number of washers, or reels, threaded upon a central core, one end of which is attached to the brake lever, while the other is fixed to the winch frame. By the application or release of this braking strap the revolving of the barrel, either forward or backward, can be completely controlled at will.

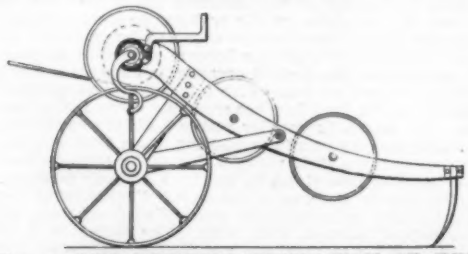
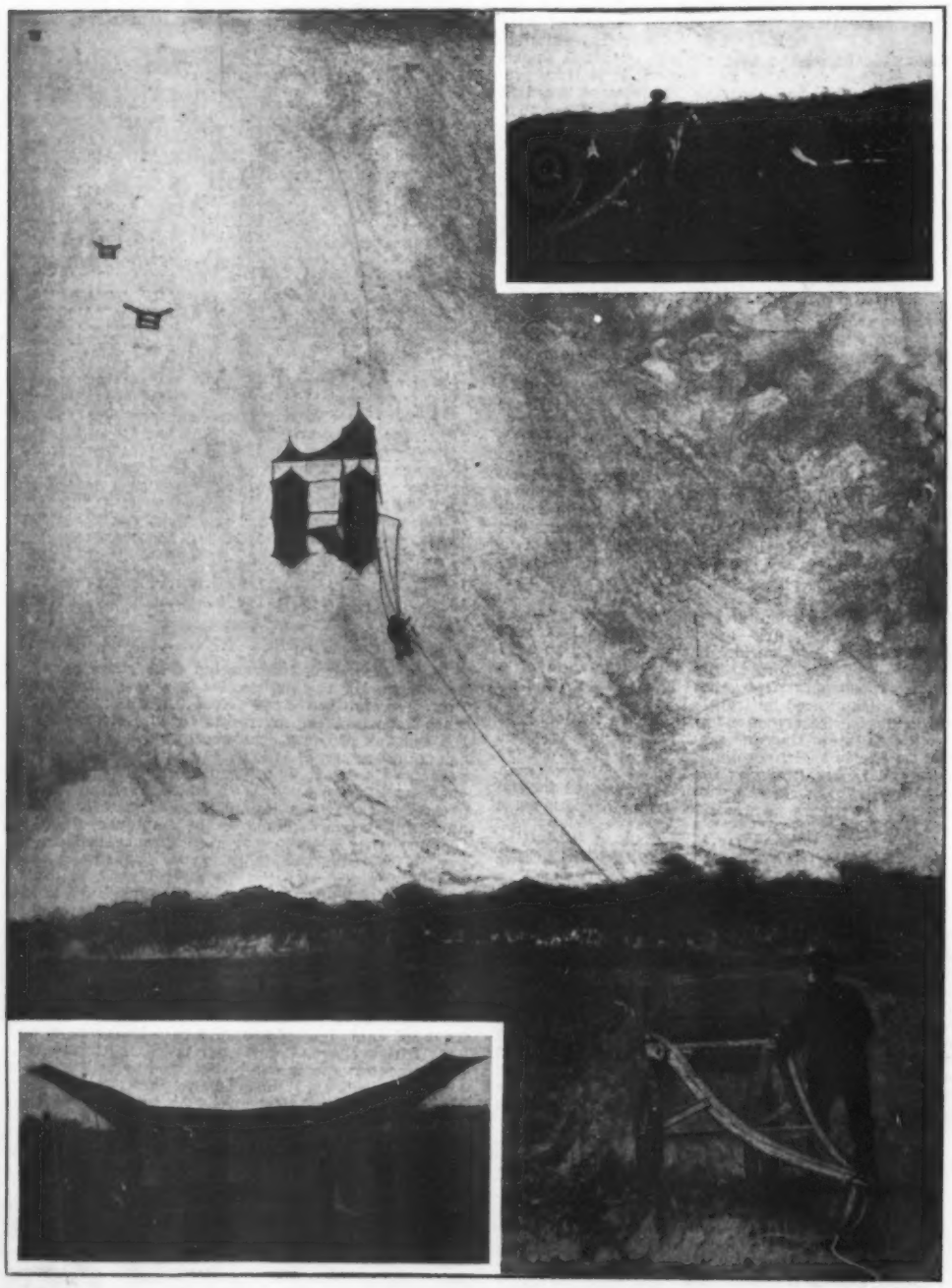


FIG. 2.—THE WINDING MECHANISM OF THE CODY KITES.

The winch is furthermore provided with a pawl and ratchet, to prevent paying out of the cable, but is so fitted that if it is desired to release the cable quickly, it may be immediately thrown out of action. The person in the traveling car can also exercise control of the winding mechanism when in the air, by means of a cord connecting the basket to the winding drum, passing in its course over guide pulleys on the winch frame, so that when the rope is pulled the brake is applied, and *vice versa* when this guide rope is slackened. It will therefore be seen that the person in the car always has the winding drum completely under control, irrespective of the attendant in charge of the winding carriage, and can regulate thereby his height in the air as desired.

Mr. Cody has carried out several flights with his kites, which have been attended with conspicuous success. Great altitudes have been attained, and many valuable meteorological observations obtained thereby. For this latter operation the orthodox self-recording meteorological instruments for such work are employed. He has also made many important ascents, which have conclusively demonstrated the lifting capacity of his apparatus.



MR. S. F. CODY EXPERIMENTING WITH HIS WAR KITES.

1. Placing kites in position for a government experiment. 2. The kites in air, and the special winding apparatus. 3. The kite ready for an ascent.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

BIG THINGS OF THE WEST.*

By CHARLES F. HOLDER.

WHETHER rightly or not, the West has earned a reputation for big things—big fishes, big fruit, big trees; and so many really big things come from this section of the country, that possibly some of the inhabitants fall naturally into the habit of telling big stories and painting as they rise. There are, however, certain peculiar conditions that hold on the Pacific slope that justify the story teller. The West has the largest trees in the great Sequoias which rear their lofty heads two or three hundred feet in air. It possesses the giant redwoods, which possibly rank next in size and usefulness, great forests extending all along the fog-laden country of Northern California. In Alaska we find the highest mountains in America, and the largest and most numerous glaciers, beginning with Muir and Malispina, the latter the most remarkable glacier in the world. The stroller through the markets of San Francisco will find the western representative of the New York weak-fish—a huge creature ranging from eighty to one hundred pounds—and will be told that a similar fish is caught in the Gulf of California weighing two hundred pounds. In the Italian quarter of this city will be seen the octopus, or devil-fish, hung up for sale, a terrible array of arms or tentacles; not the little creature a foot or two across common in the East, but a veritable monster with a radial spread of perhaps twelve or fourteen feet. Along the upper coast these animals have been found with a radial spread of twenty-five feet—well named the spider of the sea. Along the coast will be seen a bass which often tips the scales at five hundred pounds; and at Monterey has been taken a mackerel weighing nine hundred pounds—suggestive that even fishes grow large in western waters. In Alaskan waters is found a monster clam, the "geoduck," one of which would afford a meal for several persons; not so large however, as the great tridacna and its species, which weighs, with its two valves, five hundred pounds, the animal alone weighing thirty. This shell, though common in California, is from the equatorial regions of the Pacific, where, buried in the soft rock, its viselike jaws partly open, it is a menace to the natives who wade along the reefs searching for shells.

In Southern California the vegetation is often remarkable for its size. At Santa Barbara is a grapevine which covers several hundred square feet, the vine itself resembling a tree, said to be the largest vine in the world, though this is open to doubt, for some of the old vines of Spain are of enormous size. Whether it is due to the newness of the soil and the fact that it is not yet exhausted by successive farming, is not known, but nearly everything here grows very large and rapidly. The tree known as the Australian black wattle will attain a height of fifty or more feet in five years; palms the same height in less than twenty years, and eucalyptus one hundred feet in less time. So that it is a common saying in Southern California that barren ground can be taken and made to look like a place fifty years old in five years. The extraordinary growth of flowering plants and shrubs in Southern California is noticed. The eastern heliotrope grows in the form of a vine reaching twenty feet upward, covering the fronts of houses, in some way resisting the frost if at all protected by overhanging roof. In the city of Pasadena many remarkable examples of large growth are seen, one being a potato which was trained to grow upon a trellis and assumed the form of a lusty vine over twelve feet high, producing an extraordinary number of potatoes.

Some of the photographs of fields of pumpkins taken in the fall in Southern California might well be considered open to suspicion, so enormous are the productions. One pumpkin exhibited by James F. Stewart & Co in Los Angeles was so huge that a calf was held in the interior while a photographer took its picture. Doubtless the California rancher who raised this giant would tell the eastern farmer that it was "not a good year for pumpkins, either." Another colossal pumpkin raised by J. J. Teague in 1901 weighed 230 pounds, and when dug out after the jack o' lantern fashion afforded a playhouse for the rancher's little daughter, if we may judge by the picture. In the old days California pears were famous all over the civilized world for their size, but to-day this reputation applies to all fruits. Strawberries grown here are sometimes so large that three or four would fill a plate. Sweet potatoes are often mammoth—four feet in length—while the oranges, the immense navels which sometimes hang upon the trees for a year, probably excel in size any similar fruit anywhere. In a Pasadena garden in the summer of 1902 could be seen string beans with pods three feet in length, presenting an extraordinary spectacle, and as though the vine was hung with green snakes. But this extraordinary growth cannot be attributed to the soil of Southern California, as the seeds are said by Mr. Charles Richardson to have come originally from China, the growth not being abnormal, though doubtless when the wonderful plants are distributed over the State some patriotic Californian will claim that the bean is due to the remarkable soil and climate of California.

A COLOSSAL CALIFORNIAN PUMPKIN.

A GIANT CALIFORNIAN POTATO VINE.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

A PERSONAL EXPERIENCE IN RADIOGRAPHY, TOGETHER WITH THE TECHNIQUE OF STEREOSCOPIC RADIOGRAPHY.*

By ALEXANDER B. JOHNSON, M. D., New York.†

THE USE OF THE FLUOROSCOPE IN SURGERY.—The fluoroscope appears to be a very valuable aid to the medical man, in the diagnosis of diseases of the chest, but in surgical cases it has, at least in my hands, proved rather unsatisfactory and disappointing.

For the rough diagnosis of fractures, for the detection of foreign bodies when not situated in the thicker portions of the human body, it answers well, but the practical difficulties in its use, notably in cases of fracture attended by considerable effusions of blood, the faint and feeble character of the image seen upon the screen, and the marked distortion of the shadows, which, under many conditions, it is quite impossible to avoid, together with the utter uselessness of attempting to recognize lesions of bone covered by thick layers of soft parts and encased in splints of uneven contour, place a rather narrow limit upon the value of the fluoroscope in surgery. It is true that devices now exist whereby, with the aid of two tubes, a stereoscopic picture may be seen upon the screen, and I am told that another device is being constructed at the present time which, by means of a single tube, with two anti-cathodes and a rotating diaphragm, produces a stereoscopic image. While these devices will no doubt improve the quality of the picture, it is scarcely possible that they can take the place of radiographs. For the use of the fluoroscope in general, two things are requisite: First, a steady illumination; second, a tube of rather high vacuum and great penetration. And it is worth remembering that a tube suitable for a fluoroscopic examination of, let us say, the adult knee-joint would be quite useless for the production of radiographs showing much detail and slight differences of density.

THE TECHNIQUE OF RADIOGRAPHY.—The strictest attention to details, from first to last, is necessary in order to produce uniformly good results. The operator must, of course, become thoroughly familiar with every part of the apparatus under varying conditions. This is particularly the case with regard to X-ray tubes, and he who purchases two or three of the best tubes obtainable, learns to know for what purposes each one is best suited and guards them with care from accidental injury, will soon learn to know, from the mere appearance of the tube, while illuminated, what sort of a result is likely to be produced in the way of a picture in a given time. Several important mechanical details must be studied, and, as far as possible, the relation of the tube to the plate and to the part to be pictured should be reduced to some definite system. It will be remembered that, as far as is known, the X-ray may be assumed to proceed from the center of the platinum anti-cathode in straight lines in all directions from a point or focus upon its surface. There follows the well-known rule also applicable to ordinary light-rays, that the intensity of the illumination of an object varies inversely as the square of its distance from the source of light. When applied to radiography, this physical fact is important to bear in mind, *e. g.*, if a good radiograph of a given part can be obtained at a distance of, say, 12 inches in one minute, at a distance of 24 inches, an exposure of four minutes will be required to produce the same result. Since in practice it is necessary, on account of the varying thickness of different parts of the body, to vary also the distance of the tube from the plate between limits which may reach from 12 to 24 inches or more, this difference in time of exposure becomes a very important practical detail. In fact, to determine the proper time of exposure for a given case, in order to produce a negative having certain definite qualities, is the most difficult question which the X-ray operator has to answer. Inasmuch as many of the problems which are to be solved do not admit of answers which can be measured mathematically, the elimination of this single error of the relation between distance and time is a matter of a great deal of consequence. I have prepared a table of comparative times and distances, based upon an exposure of ten seconds at a distance of 10 inches, and have calculated the additional time necessary for all distances from 10 to 24 inches, and from ten seconds to seven minutes. I find this table a useful aid for reference. In the effort to formulate a general rule for the duration of exposure for the production of radiographs, Donath ("Die Einrichtung zur Erzeugung von Roentgen-Strahlen," Berlin, 1899) has constructed a table upon the following basis: It is assumed that the various parts of the body possess a power of absorbing X-rays, which varies directly as their density, and, if the absorbing power of the middle hand through the metacarpal bones be taken as the unit of measurement of this quality, experiment and calculation give the following values for the absorbing powers or resistance to the passage of the rays of the different parts of the body.

	Resistance
Hand	1.
Forearm	1.4
Elbow	1.5
Upper arm	1.8
Shoulder-joint	3.
Collar-bone	2.7
Neck	3.
Skull	4.5
Thorax	3-4
Sternum	3.8
Foot	1.4
Knee	2.
Leg	1.8
Thigh	3-5
Hip-joint	5-6
Pelvis	8-10

Donath has also constructed a general formula for the determination of the proper time of exposure in

* In order to bring this paper within the limits of a journal article, it has been necessary to omit a description of the apparatus employed. This quite important section will, however, be incorporated in the reprints which those interested may obtain on application to the author or may consult in the medical libraries.

† Medical Record.

any required case. The formula is based upon the above relative table. The terms are:

a = the distance of the tube from the plate in the radiograph of the hand.

b = the distance of the tube from the plate in the picture which is about to be taken.

x = the proper time of exposure sought.

z = the time of exposure necessary to produce a radiograph of the hand.

w = the resistance of the part of the body which it is proposed to take, compared with the resistance of the hand. (This number is of course, taken from the table of relative resistances.)

The formula then reads:

$$x = z \times \frac{(b)^2}{(a)}$$

While I have not made practical use of this formula, I fear that individual variations in the densities of the different parts of the body might sometimes render it inaccurate. It is necessary, of course, in every case to establish the unit, *i.e.*, the time required to take a picture of the hand; but a slender hand is often present in an individual whose abdomen is unusually thick; and a heavily-boned limb is not infrequently seen attached to a comparatively thin trunk. It will be found also that a slight change in the term *w* produces a considerable change in the term *x*.

In addition to the variation in time for distance, the much more difficult problem remains to be solved of estimating the various degrees of penetrability for limbs of different thickness and for individuals of different ages. The tissues of children are far less dense than those of adults, and require a much shorter time even for a given thickness of tissue. The tissues of women are more pervious to the rays than are those of men, and require a shorter exposure. To estimate the relative values of these different factors requires the judgment born of experience. To lay down even an approximate rule appears to me quite unprofitable, on account of the extremely varied character of the apparatus used, and the variations of the same apparatus under different conditions. With the apparatus which I possess, I use chiefly two tubes for different sets of cases. For all parts of the body thinner than the hip-joint I prefer the Queen self-adjusting tube with an extra heavy platinum anode. This tube permits me to use somewhat less than half the total practicable energy of my coil. This represents a heavy stream of sparks, 10½ inches long, measured on the parallel spark-gap of my coil and the No. 16 platinum wire of the Wehnelt interrupter, protruded 4 millimeters into the acid. To obtain the greatest amount of detail in my pictures of the thinner part of the body, I use with this tube a vacuum which corresponds to a resistance equivalent to from 2½ to 3 inches, measured on the spark-gap of the tube. The current used is the 110 volts direct street current, and from 4 to 5 amperes. This gives rather a black picture of the hand in the fluoroscope. The bones appear very dark and the soft parts somewhat lighter—but still not very light. The tube, in this condition, would not be suitable for a fluoroscopic examination of the bones of the leg nor even for the elbow-joint in the well-developed male subject. When using this tube for a radiograph picture of the knee-joint of a well-developed adult, I increase the spark-gap of the tube to 3½ or 4 inches. This gives a bright, clear picture of the hand in the fluoroscope, and in this condition the tube would be suitable for the fluoroscopic examination of the adult elbow and for a moderately well-developed leg. The necessary times of exposure to produce radiographs with this tube are about five times as great as with the cold-water tubes of Dr. E. Grünmach, about to be described. This cold-water tube is intended to be used on a coil giving a spark-length of 16 inches. The penetrating and photographic power of this tube far exceeds that of any other with which I am acquainted. It can be used with an amount of energy equivalent to a very heavy stream of sparks 14 inches in length for from three to four minutes continuously, without any serious change of vacuum. If the current is kept up for longer than four minutes the anode becomes heated to a dull red heat, and the vacuum falls a little, but upon turning off the current the tube recovers itself almost completely in two minutes.

With this tube, using a vacuum representing a resistance equal to from 8 to 10 inches of spark-length upon the parallel spark-gap of the coil, it is possible to take fairly good radiographs of the thicker portions of the extremities in an astonishingly short time. A fair radiograph of the hand and forearm may be taken with an exposure too short to measure—practically instantaneous. The knee-joint may be exposed for ten to fifteen seconds with fair result. I have taken a very good radiograph of the spine, pelvis, and both hip-joints of a well-developed boy, ten years old, in thirty seconds. The amperage of the current used under these conditions was between seven and eight amperes. Even shorter exposures than this are said to be sufficient. But in practice I find that pictures showing more detail and slighter differences in density can be produced by a different method, *i.e.*, by reducing the resistance of the tube and its vacuum to a degree equivalent to from three to four inches upon the spark-gap of the coil. When used in this way, the tube gives a fluoroscopic picture of the hand which is clear, but fairly dark. And yet, with the tube in this condition, my best radiographs of the spine and pelvis of adults have been obtained. The exposures necessary to produce strong negatives are as follows:

Adult hand and wrist, distance of tube from plate, 13½ inches, 10 seconds.

Adult elbow, distance 16 inches, time 30 seconds.

Foot and leg, 16 inches, time 45 seconds.

Knee-joint, distance 18 inches to 2 feet, time 2 to 2½ minutes.

Shoulder-joint, 21 inches to 2 feet, 2½ minutes.

Thorax, distance 2 feet, 3 minutes.

Adult hip-joint, pelvis, spine and kidney regions; females, 4 to 6 minutes; males, 6 to 8 or even 10 minutes; distance 24 to 26 inches or more.

I do not find, however, that it is possible with this tube to get pictures showing such slight differences of density as with the Queen self-adjusting tube, before described. The farther away the tube is placed from the object to be photographed the less the distortion of the picture. In the case of the thinner parts of the body, this distortion is only slight when the tube is placed, say, 15 or 16 inches from the plate, but when a picture is taken of the hip-joints, including the pelvis of an adult, and the tube is placed in the middle line of the body, unless the distance of the tube from the plate is more than two feet, the distortion is great. The practical lessons to be drawn are, that it is advantageous to place the tube as far away from the body as is consistent with a reasonable time of exposure, and in all cases involving an exposure or exposures in the aggregate of five minutes or more, to lessen the risk of dermatitis by anointing the patient's skin abundantly with some greasy preparation—lanolin for example—and by placing between the tube and the patient a grounded screen, consisting of thin cardboard, or wood, coated with gold foil, or with a thin sheet of aluminium. Whether these measures are an actual protection against burns or not, I am unable to say, but it is probable that they do serve to lessen the likelihood of a subsequent X-ray burn, to some degree at least. When using powerful tubes with a current of great frequency of interruption, high intensity, and considerable amperage, the possibility of producing X-ray burns, when taking pictures involving several minutes of exposure, should never be lost sight of. The danger is a very real one. If the operator will keep an accurate record of all the conditions under which each X-ray picture has been taken, he will gradually accumulate a very valuable series of data. Such a record should include the part of the body, the age of the patient, the quality of his tissue, whether fat or lean, flabby or firm, whether large-boned or delicately built, the distance of the tube from the plate, the particular tube used, the resistance of the tube, during the time of exposure, measured on the spark-gap of the coil, the fluoroscopic picture of the operator's hand during the time when the picture is taken, the position of the rheostat lever, the distance to which the platinum wire of the Wehnelt interrupter was protruded into the acid while the picture was taken, the kind of plate used, the kind and strength of the developer, the time of development, and the general character of the negative.

Any examining table of firm construction answers very well for taking X-ray pictures. It is convenient to use a table, the three sections of which may be tilted at various angles so that certain of the patient's muscles may be relaxed as he lies upon the plate. In this way it is often made more easy to keep the part to be pictured quiet and in firm contact with the plate and the patient comfortable during the exposure.

The device which I use for holding the tube is made in the form of a gallows. The vertical arm of the gallows is firmly clamped to any desired part of the table, and slides up or down, vertically, in a suitable frame. The distance of the surface of the anti-cathode from the plate is marked in inches on this vertical arm.

The horizontal arm extends over the table; it is also graduated in inches. The construction of this gallows is of wood, heavy and solid, to prevent vibration.

Upon the horizontal arm there slides a heavy wooden clamp, which hangs vertically downward.

Its jaws are arranged to hold the tube horizontal, the long axis of the tube and the table parallel.

The tube can thus be moved horizontally or vertically a measured distance, and is held by suitable locking screws, quite immovable, if desired.

It is convenient to lead the wires from the coil to the tube over a light stand or framework of wood, which may be elevated to a position several feet above the patient's body. In this way accidental shocks are prevented, and the patient is less likely to disarrange the apparatus during clumsy efforts to get on or off the table. The operator is also enabled to walk all around the table underneath the wires, in order to make such adjustments as are necessary. The body of the patient should be placed upon the table in such a position that the part which it is desired to show upon the plate with the greatest clearness lies vertically beneath the center of the anti-cathode. For the determination of this relation a plumb line is useful. The patient must be made comfortable by means of pillows and blankets, so that no part of the body is in a condition of muscular tension.

That surface of the limb or trunk nearest to which the lesion is supposed to lie is placed next to the plate.

Some ingenuity in arranging the patient is required at times.

In determining the question of the distance of the tube from the plate, it is a good rule to follow not to put the anti-cathode nearer than 12 inches from the skin, and for long exposures a distance several inches greater should be chosen.

The time of exposure for the given case will depend, as has already been remarked, upon a number of different factors. A high vacuum tube admits of a short exposure, but the negative produced will show but little detail. A low vacuum tube, even with the same current, will require a longer time, but will produce a negative showing far more detail, and will exhibit much slighter differences of density. Thus, if the question to be answered is merely, what is the extent of deformity in a case of fracture? the diagnosis of fracture being evident by ordinary means of examination, or if it is to be determined whether or not a metallic foreign body is present, a high vacuum tube with a short exposure answers well. If, however, the question relates to the presence of a calculus, renal or other, to disease of bone, or to pathological changes in the blood vessels, or, if, in the case of a tumor, it is supposed that the mass consists partly of bone and partly of softer structures, or in any case in which it is desired to show the greatest possible differentiation of density, a low vacuum tube should be used of just sufficient penetration to furnish a strong negative after a reasonably long exposure. I have already given the results of my own experience, but the reader will remember that the time of exposure varies much with different forms of apparatus.

And a certain amount of experimental work is necessary to determine the efficiency of any particular set of apparatus. The more powerful the coil, the larger the energy of the secondary discharge; and the greater the capacity of the tube to endure a heavy current for a long time, the shorter the exposure.

The time of exposure having been settled, the plate is to be inserted beneath the part to be taken. In order to avoid the danger of the pressure of bony parts upon the glass, producing a fracture of the plate, it is desirable that some protection against this accident be used. For this purpose the plates in their envelopes are inserted, one at a time, into a shallow wooden drawer-box, not unlike in appearance an ordinary plate-holder. The box has a solid bottom of wood, bearing upon its upper surface two brass springs, which serve to keep the plate in contact with the top of the box. The cover or top may be made of any light fairly rigid material pervious to the rays. Mine are covered with a very heavy stiff paper of fiber board.

The space between top and bottom is open at one side of the box; and the space is wide enough to permit a plate in its envelope to be easily inserted and removed.

It is convenient to have these holders of several sizes. For plates as large as 14 x 17 I use a broad framework of planking, across which there slides a long and shallow wooden drawer, above which is a stiff paper cover. The patient lies down upon the paper cover, a plate is inserted, and the drawer closed. After the exposure is made, the plate may be withdrawn and another inserted without any change of position on the part of the patient. Before turning on the current, the operator should have informed himself of a number of details in regard to his apparatus. He should know just how much energy the particular tube he is using will stand, and for how long; and this once determined, he should use the same amount of current and the same rapidity of interruption with that tube for every case, or his results will not be uniform. He should also know by trial whether the vacuum of the tube is suitable for the case in hand. If it is already too low, the tube will not answer for that case; if too high, he must reduce it to the proper point, to be determined by the parallel spark-gap and the fluoroscope.

To know what degree of vacuum in a given tube is best suited for a radiograph of a given case requires, above all things, experience. But a general idea may be obtained by the appearance of the bones of the hand in the fluoroscope. If the shadow of the hand is so dark that the bones cannot be seen distinct from the flesh, the tube is only suitable for the thinner parts of the extremities, and for them only in case the tube in question permits the use of a large amount of energy. The relation between the penetration, as shown by examining the bones of the hand, and the power of the tube to produce a picture of a part of a given thickness is not absolute, but relative. For example, a high vacuum tube, giving a good fluoroscopic picture of the thorax, but which permits the use of a small amount of energy may entirely fail to produce a satisfactory picture of even a part as thick as the adult knee-joint in any reasonable time; whereas a tube of very low vacuum indeed, through which a heavy current may be passed continuously for several minutes, will often produce a good negative in a much shorter time. A tube of medium vacuum,, such that the bones of the hand when viewed through the fluoroscope show clear and distinct and sharply marked, while the flesh is much lighter, is, upon the average, best for general work.

A very high vacuum tube is but of little use for taking pictures. The operator will, in general, be obliged to establish his own standard, it being true of radiography as of most other practical arts, that an ounce of experience is worth several pounds of precept.

In general, one is much more likely to expose for too short a time rather than for too long, and whereas the negative produced by an over-exposure is still capable, with careful development, of furnishing a good picture, an under-exposed plate is hopeless, and no amount of development will bring out that which is not there.

Distortion.—Owing to the fact that the X-rays originate from a point of focus upon the surface of the anti-cathode, and proceed in straight lines in all directions from its surface, and since no one has as yet been able to refract the X-rays by means of prisms or lenses, it admits of a simple demonstration that the projections of any two points in the same vertical line placed between the surface of the anti-cathode and the photographic plate, but removed from the vertical dropped from the anti-cathode on the plate, will fall upon the plate at two points separated by a horizontal distance, the extent of which will depend upon the distance of the anti-cathode from the plate, the distance of the two points one from the other vertically, and upon certain other special relations unnecessary to elaborate.

In other words, a figure made up of many points, situated at various levels, will be projected upon the plate as a distorted image, and apparent deformities will be exhibited in the picture which do not exist. This distortion is more marked the nearer the tube is to the plate, the thicker the object, and the farther it lies from the vertical. In the case of the thinner parts of the body the distortion is slight at ordinary distances, but, in radiographs of the hip-joint, for instance, at similar distances it becomes extreme, and may render the negative quite worthless for diagnostic purposes. Distortion may be avoided by placing the tube as far away from the plate as is consistent with a reasonable time of exposure. To one acquainted with the relation of the tube to the plate in any given case and accustomed to inspection of X-ray pictures moderate degrees of distortion may be discounted, but inasmuch as the medico-legal relations of radiographs are important in certain cases, it behooves us to make a careful adjustment of the tube and the part, and to keep an accurate record of the data.

Attempts on my part to look at distorted pictures through lenses in order to correct the distortion have not as yet met with success.

Specific directions for the position to be assumed by a patient in order to get the part to be radiographed in the most favorable relation to the tube and plate might be given for different parts of the body, but the anatomical knowledge of the operator will usually suggest to him the best arrangement.

Some space, however, may be devoted to the use of the X-ray in the detection of renal and ureteral calculi.

The use of the X-rays for this purpose is of general interest, and most of my own work has been done in this direction. In my experience, the technique does

not differ materially from that necessary to obtain good pictures of the bones, joints, etc.

The amount of electrical energy used must be considerable, in order to furnish enough penetrative power. The tube should be of a medium vacuum, and must permit the use of a heavy current for several minutes. In order to avoid the danger of burns, the tube must be placed at least twelve inches away from the skin, and the abdomen, thighs, and thorax should be thoroughly greased. The screen may also properly be used. The time necessary, with my apparatus, to produce a negative showing sufficient detail to make a positive or negative diagnosis varies from four minutes for a slender woman to ten minutes for a very stout man.

I am in the habit of placing the tube from fifteen to eighteen inches from the skin. The patient should lie upon his back, with the plate beneath him.

The knees should be flexed upon the thighs, and the thighs upon the pelvis, and supported in this position by a suitable cushion beneath the hams. By this means the back will be brought in contact with the plate.

The bowels should have been thoroughly evacuated, and the stomach should be as far as possible empty, at the time the picture is taken.

If the individual is small, or even of medium size, a plate fourteen inches wide will include the kidney region and the entire course of the ureter. For large individuals it is necessary to use a wider plate, or to take two pictures, one of the kidney region and one of the ureter.

If the first picture, including both kidney and ureter regions, is sufficiently good, it does not appear to be necessary to take another. A good picture should show the outlines of the vertebræ, their spinous and transverse processes, the structure of the sacrum in considerable detail, the outlines of the pelvic cavity, the last two ribs, the psoas muscles, and to establish a negative diagnosis, the lower half of the kidneys with fair distinctness. A much worse picture than this, however, will, in the majority of cases, furnish a positive diagnosis of kidney stone, and I have been able to see the shadow of a ureteral stone, weighing but two and one-half grains, on a plate which did not fulfill the above requirements.

An oxalate stone, as large as the last joint of one's little finger, casts a shadow fully as distinct as, for instance, the last rib.

But for diagnosis establishing the absence of stone one must, of course, obtain the very best possible negative. If the structures are seen, as above described, I do not believe that any calculus can fail to cast an appreciable shadow on the photographic plate. The plates should be dry before a definite opinion is given as to presence or absence of a stone, and should then be examined by standing them in front of a piece of ground glass, behind which is a source of light. If the plates are thin, it is advantageous to put two pieces of ground glass behind them.

The relative values of shadows upon such a plate can often best be appreciated at a distance of eight or ten feet; but, in my experience, the shadow produced by a stone, if it shows at all, is so distinct as to be absolutely unmistakable. Nor should an opinion be given unless such is the case.

There are several pitfalls into which the inexperienced and unwary may fall in regard to the diagnosis of kidney stones as shown by the X-rays. It is positively necessary that the negative should be good enough to show the previously enumerated normal structure. A plate which does not do this is worthless, usually, as a means of negative diagnosis. It is, moreover, necessary that the plate should be studied after it is dry in front of a suitable ground-glass screen.

A careless observer might mistake the tip of the transverse process of one of the lumbar vertebræ where it projects beyond the border of the psoas muscle for a stone. The tip of the twelfth rib in certain cases in which this rib is very short, and its proximal extremity not clearly defined, may lead to the same error.

Bacterial colonies are very frequent upon the gelatin films of certain X-ray plates, and at times might lead to error. But with a little practice they are not difficult to distinguish from the shadow of a stone. If the plate be looked at by reflected light from the sky, one can see that these spots produced by colonies of bacteria are not mere shadows, but represent a gross mechanical change in the gelatin film. In order to avoid their occurrence some manufacturers impregnate the emulsion with formaline.

There are, moreover, certain shadows which occur upon radiographs of the pelvis which might well be mistaken by the inexperienced for stone in the ureter. I have found these spots in three cases, and as yet I do not know their nature. They occur as rounded shadows varying in size from a B.B. shot to a small buckshot. Several are usually found upon one picture, and sometimes upon both sides of the pelvis. They are of about the same density as the ureteral stones. These shadows are arranged on a line which forms a gentle curve, with its convexity outward and downward, quite close to the bony contour of the pelvis, as projected upon the plate. They may be found anywhere from a point one inch above the spine of the ischium down to what seems to me to be close to the region of the prostate. They are, however, situated too far away from the median line either to be in the ureter or the seminal vesicle. I have thought that these shadows might represent calcareous deposits in the iliac veins.

Occasionally the crura of the diaphragm, as they pass to the body of the first lumbar vertebra, may cast shadows of a vague character which might possibly be mistaken for kidney stone. At least, such a statement is made by others, although I never had occasion to verify it.

There are also shadows resembling those cast by stones, the exact cause of which I have not been able to determine, and I have only noticed them upon the plates of one manufacturer. The plates manufactured by Cramer and by Seed do not present these defects. The shadows are usually in the neighborhood of a minute spot no larger than the head of a pin where the film seems to be absent. The shadows themselves are somewhat larger.

Areas of fog may also produce deceptive appearances to the uninitiated, but a plate which is fogged at all is generally worthless for purposes of diagnosis.

Those plates which are sold for the purpose of taking X-ray pictures are often placed by the maker in paper envelopes ready for exposure. If the plates are entirely fresh when purchased and are used within a month this is a matter of no consequence, but if kept for some time the contact of the paper with the film produces a peculiar mottled appearance which renders the negative quite useless. It is better then to purchase plates which are not inclosed in envelopes and to put them in the envelopes shortly before they are to be used, or if plates already inclosed in envelopes are desired, to buy them a few at a time direct from the manufacturer and insist upon those recently made.

It is, of course, necessary to keep X-ray plates either in a thick metallic box or else in a room far removed from the coil; for the distance at which they may be affected by X-rays is very considerable.

THE DEVELOPMENT OF X-RAY PLATES.—Any of the developers now popular are good enough, such as pyro, metol, hydrochinon, eichonogen, rodinal, etc.

It is very desirable that the surgeon should develop his own plates, if time can be spared for the purpose. It is too much to expect that any one else will exercise the same care and patience in the effort to perfect the work of another; and much valuable knowledge and satisfaction is to be derived from developing the plate which one has himself exposed. Moreover, the probable character of the negative is best known to the individual who made the exposure. He will, with a little practice, best know how to make the most of a given plate in order to show the thing which he desires to make prominent.

If there is reason to believe that a plate is overexposed, a diluted developer should be used; if not, it may be used of the ordinary strength.

When developing radiographs of the hip-joints and pelvis, I am in the habit of using a weak developer on account of the possible danger of ruining these negatives which cannot immediately be replaced without risk to the patient. To avoid danger of fogging an important plate, it is best to carry on the development in absolute darkness, only exposing the plate to the red light from time to time momentarily in order to judge how the development proceeds. For the development of hip-joint, spine, and pelvis cases, from ten to fifteen minutes is enough; for thinner parts of the body, from six to ten minutes, according to what is desired to show. If it is desired to show with the greatest clearness the structure of bone and to blot out the soft parts, a form of negative very popular for purposes of exhibition, the development should be carried to a point where the bones themselves appear distinctly dark and the soft parts can scarcely be distinguished from the uncovered portion of the plate.

If, on the other hand, the soft parts as well as the bones are to be preserved on the negative, and in all cases when the radiograph is to be viewed in the stereoscope, a more useful and interesting picture will be obtained by stopping the development while the soft parts are still quite a little lighter than their surroundings and the bones are gray but perfectly distinct.

In this description it is assumed that the exposure has been sufficiently long; otherwise, no amount of development will serve to bring out detail which is simply not there.

The use of the so-called "acid-hypo" bath which hardens the gelatin film and prevents the most annoying accident known as "frilling" is well worth the additional trouble involved in its preparation.

While those unaccustomed to the examination of X-ray negatives sometimes find it difficult to appreciate what they represent, and it is therefore necessary to prepare prints or positives, yet much of the value of the radiograph is thereby lost unless the printing is in painstaking and skillful hands. I have been unable to get professional photographers to do this work well, and therefore do it myself when I must, but the surgeon rarely has sufficient time to devote to this and must put it into the hands of another.

Satisfactory prints of plates showing kidney and ureteral stones are especially hard to make. The different portions of the body are inevitably penetrated to different degrees, and, in order that every portion of the plate should be printed to the proper density, it is necessary to use screens of tissue paper when printing by daylight.

The proper arrangement of these screens for a given case must be learned by experience.

STEREOSCOPIC RADIOGRAPHY.—Although a good deal of attention has been given to this method of taking and looking at radiographs in England and Germany, and to some extent in Canada, so far as I am aware but little work of this kind has been done in the United States; and the main purpose of this paper is to call attention to certain advantages which may be obtained by this means with but little additional trouble and expense. The technique is quite simple, and demands but little more care and attention than the taking of two ordinary separate pictures. The advantages which may be claimed for stereoscopic radiography are that it renders the localization of foreign bodies simple and accurate; the character and extent of deformity in cases of fracture cannot be so well appreciated in any other way. The exact positions of bones in cases of dislocation are shown in their true relations, and the same is true of deformity of bones produced by disease and congenital anomalies. The relations and origins of tumors growing from bone may be appreciated in parts of the body which are not open to ordinary palpation. For instance, tumors growing from the anterior wall of the sacrum at a high point, and certain diseases of bone, can be recognized at an early stage with great clearness, so that it may be said that by the use of the stereoscope the value of radiographs is notably increased.

The method depends for its value upon the well-known principle of the stereoscope, viz., that in order that we may see any near object, as a solid body showing relief, and appreciate the special relations of different points of the body to one another, it is necessary to view it with both eyes. The effects produced by the stereoscope depend upon the production of two pictures taken from two different points of view, and the separation of the points one from the other is made equal to about the distance between the visual axes of the two eyes, viz., two and one-half inches.

In radiography, a little more or a little less does not appear to be of great consequence.

The method may be applied in two ways. Two pictures may be taken from the same point of view, the object being moved, or the object is kept stationary and the second picture is taken from a point distant two and one-half inches from the first. As applied to radiography, this principle may be utilized in several ways which vary only in detail. The X-ray tube is placed over the photographic plate with some part of the body intervening, and a picture is taken. The plate is then removed, and a second plate is substituted without moving the object. The tube is moved two and one-half inches horizontally, and a second picture is taken.

One-half of the plate may be screened by a sheet of lead during the first exposure, and in the second exposure the first half is screened and the second exposed. When this latter method is used, the plate is photographed, and thus reduced in size to a degree which renders it suitable for viewing with the refracting stereoscope. A print is made from the reduced plate, and looked at in the ordinary refracting stereoscope with which everyone is familiar.

There are optical difficulties in the way of the construction of the refracting stereoscope for looking at pictures of large size which appear to be insurmountable at the present moment; at least, my efforts in this direction have not met with success.

Another method which has chiefly been used in England is as follows: Two radiographs are taken from different points of view; prints are made from these plates and viewed in the Wheatstone reflecting stereoscope. The pictures are, of course, life-size.

Both of these methods are subject to certain disadvantages. A good deal of time is required before the print can be prepared, and much care is necessary to mount them properly; considerable expense is also incurred. Moreover, when the pictures are diminished in size to the extent necessary for the use of the refracting stereoscope, the finer details are not so easy to see, and in general it may be said that prints made from radiographic plates are never as full of sharp detail and contrast as are the original negatives.

When the prints are to be viewed in the reflecting stereoscope, it is necessary that one of them should be printed reversed, or from the glass side of the negative.

The difficulties of producing a clear picture in this way are considerable.

They may be overcome by rendering the light rays which fall upon the plate parallel.

This can be accomplished by placing the printing frame at the bottom of a cylinder of approximately the same size as the frame and about six feet long.

In this way the clearness of outline in the print may be preserved, but the method is troublesome.

This difficulty may also be overcome by printing one of the pictures by the carbon process in which the sensitive film may be floated off and reversed and transferred to paper under water.

The mechanical details are troublesome, difficult, and expensive, and some distortion of the film is very likely to occur during the transference.

A third method, which I have been using with satisfaction, is to view the negatives themselves by transmitted light with the aid of a Wheatstone reflecting stereoscope.

The advantages of this way of looking at radiographs appear to me to be considerable.

1st. Time is saved. The negatives may be put in the stereoscope within one hour of the time when the exposures were made—obviously a great practical advantage.

2d. None of the fine details of the negative are lost, whereas in negatives made with a low vaccum tube it is often possible to make out stereoscopically the muscles, tendons, ligaments, subcutaneous fat, and other structures in a manner so vivid as to be quite startling. It is, in my experience, hopeless to attempt to reproduce these details with the same degree of clearness in a print. When stereoscopic pictures of the entire pelvis and both hip-joints of adult individuals are taken, as is often desirable, in order to contrast the two sides of the body, the method presents certain difficulties. The tube must be placed a long distance from the plate, in order to avoid undue distortion, and consequently much longer exposures are necessary, but for all ordinary pictures these difficulties do not obtain. The necessary apparatus for making and looking at stereoscopic pictures may easily be improvised at a cost of a very few dollars. For taking the pictures the tube-holder already described and the plate-holder answer well. To the tube itself is attached a paper protractor from the center of which hangs a weighted thread, so that the inclination of the plane of the anticathode to the photographic plate is indicated by the position of the thread, where it cuts the angles marked on the protractor.

The rotation of the tube upon a horizontal axis varies the angle to any desired extent. The thread also serves as a plumb line whereby the relation of the anticathode to the center of the plate is easily seen. The plate and the object to be radiographed are arranged beneath the tube in such a manner that the anticathode lies one and one-quarter inches to one side of the vertical dropped from the center of the anticathode to the middle of the plate, and the plane of the anti-cathode is inclined slightly toward the vertical.

Theoretically, the tube should be set at angles with the vertical, which vary for different distances at which the tube is placed from the plate, as follows:

At 35.7 inches the angle of the tube should be changed, after taking the first picture, to the extent of four degrees.

At 23.8 inches the angle should be six degrees.

At 17.8 inches the angle should be eight degrees.

At 13.2 inches the angle should be ten degrees.

These angles and distances include all probable limits at which X-ray pictures are likely to be taken. Prac-

tically, the exact angle is of no great moment. The apparatus having been properly adjusted, the exposure is made. The photographic plate is then withdrawn from the holder and removed to another room. Another plate is then inserted into the holder without moving the part which is to be pictured. The tube is then moved horizontally two and one-half inches, or one and one-quarter inches the other side of the vertical. The tube is then rotated through the proper angle, and another exposure is made.

The most important practical point in the method is to place the tube far enough away, so that the distortion of the picture will not be so great as to interfere with the stereoscopic union of the two images, which is necessary in order that the effect of binocular vision may be produced. It is of advantage to place the plates in the stereoscope, hereinafter to be described, at the same distance from the mirrors as they were from the tube when the pictures were taken. Experience shows that pictures may be taken without undue distortion, as follows: The hand at 13½ inches; the elbow, 16 inches; the foot and leg, 16 inches; the knee and shoulder, from 18 to 24 inches, according to the individual; the hip joint, 24 inches; the pelvis as far away as is consistent with the penetrative power of the tube; the head, 24 inches or more; the thorax at least 24 inches.

The plates exposed in this way constitute stereoscopic pictures. For viewing these pictures, I have found the following arrangement convenient. A hardwood plank five feet long, one and three-quarter inches thick, and eight inches wide, serves as a base for the stereoscope. In its center are arranged two plain plate-glass mirrors, each one foot square. These mirrors are set at an angle of ninety degrees to one another. The apex of the angle faces one of the long sides of the plank. The mirrors slide in grooves back and forth at right angles to the long axis of the plank. Upon either side of the mirrors there are two wooden frames for holding the negatives, and also a piece of ground glass. These frames are made to hold plates measuring eleven by fourteen inches, which size is sufficiently large for most purposes. Plates of any smaller size can be used, and those of eight by ten inches are often convenient. The frames are so arranged upon brass plates suitably grooved that they slide easily along the plank; or upon a second brass plate superimposed upon the first at right angles thereto. And one of the frames may be raised or lowered by means of four large set screws with milled heads. Upon either end of the plank is placed a slate box containing two electric light bulbs. These bulbs are set upon a block of wood perforated at the four corners by four thick vertical brass rods, which also serve to conduct the current which lights the bulbs. The bulbs may be raised or lowered by means of a brass rod which projects through the top of the box.

These electric bulbs serve to illuminate the negatives by transmitted light. Two sixteen candle power lights are usually sufficient in either box, unless the negatives are very thick, in which case thirty-two candle power lights may be substituted. In using the apparatus, one or two pieces of ground glass are placed in the grooved frames close to the front of either box, and the negatives are placed, one on either side, facing each other in the grooves made for them next the mirrors. The observer sits down in front of the middle of the plank with one eye on either side of the angle made by the mirrors, from which the plates should be equidistant, and moves the mirrors toward him or away from him until the two images upon the negatives are superimposed, when the stereoscopic effect is appreciated.

As before stated, the effect occurs most easily when the plates are as far from the mirrors as they were from the tube at the time of taking the radiograph. It sometimes happens that certain individuals are at first unable to make the two images join and appear as one. But a very little practice, usually a few moments, suffices to overcome the difficulty; and the habit once acquired, it is hard to see the pictures separately even when they are displaced considerably from their proper positions. It is desirable that a darkened room should be used to get the best effect. It is also desirable that the pieces of ground glass should be placed close to the box inclosing the lights, so that no light is observed except that which comes through the pictures. For this method of inspection the negatives should not be excessively dense, and surprisingly good effects are obtained with negatives so thin as to be disappointing when viewed by ordinary daylight.

It is by no means necessary to construct so elaborate an apparatus for viewing these pictures stereoscopically. The mirrors may be set in a simple box of wood and placed upon an ordinary table. Two other blocks of wood, suitably grooved for holding the plates and the ground glass, may be placed on either side of the mirrors, and any fairly powerful source of artificial light will answer for illumination. The pictures must, of course, be upon the level, or they will not combine. I have found this method of looking at X-ray plates very useful in a variety of conditions. The depth of foreign bodies from the surface and their relations to bones are appreciated with great ease. The character and degree of displacement in fractures can be recognized with great accuracy; the same is true of dislocations. The relations and depth of bony lesions from the surface can be accurately located. The exact character of a recent operation done upon a bone can be described as accurately as though the observer had seen the operation performed; and a much clearer idea of the structure and relations of bony tumors can be obtained than is possible by any other means that I am acquainted with, except an open operation.

The limits of this article do not permit me to treat of special lesions nor of special cases, and I have purposely confined myself to a general consideration of the topic.

It is my hope that I may at least have influenced others to try a method which but slightly increases the necessary trouble and expense of taking radiographs, and at the same time furnishes much greater clearness in the results obtained and enhances the value of radiography in several directions to a marked degree.

AUTOMATIC DISCHARGE OF BALLAST FOR FREE BALLOONS.

A NOVEL feature in aeronautics is introduced by MM. de Castillon de Saint Victor and Leo Dex in the form of free balloons, launched independently, without crew, and allowed to follow their own course. The date of departure is so fixed that the balloons, starting from Cabes (Tunis) are borne by a north wind over to the Sahara Desert, where they are caught by the northeasterly trade wind prevailing there and are drifted toward Timbuctoo, which it is hoped they will reach, unless unforeseen complications arise.

These balloons possess an exceptional vitality, for, as they carry no passengers, they can take up with them an unprecedented load of ballast. Means must, of course, be provided for this ballast to be served out automatically according to the requirements of the instant. The devices resorted to for effecting this depend for their working on the nature of the ballast. One portion of this takes the form of a long, heavy steel rope of special construction, while the remainder is supplied in the shape of 185 gallons of water contained in a sheet-iron tank. These guide ropes and the automatic discharger of the water were constructed at Chateauroux, and the results of the preliminary tests to which they were subjected have turned out thoroughly satisfactory

The principal discharger, then, consists of a large sheet iron tank provided below with a copper valve, which the tension of a spring tends to open, as is clearly shown in our third figure, while the valve is normally held closed by the weight of a steel ball suspended from it at the end of a long copper wire. The sphere is fixed in a stirrup in which it rotates freely. If the balloon, losing its buoyancy, approaches the earth, the sphere presently rests on the ground, and consequently the valve of the water tank opens. The balloon thus freed of a portion of its ballast rises, bearing aloft the steel ball, which had been dragging after the balloon, rotating in its stirrup. The valve therefore again closes and the discharge of ballast ceases.

Our second illustration shows how a workman has partially lifted the steel ball by means of a lever, with the result that the water is pouring out in floods from the tank, at the rate, in fact, of 80 liters per minute. On allowing the ball to fall back, the workman stops the flow of water.

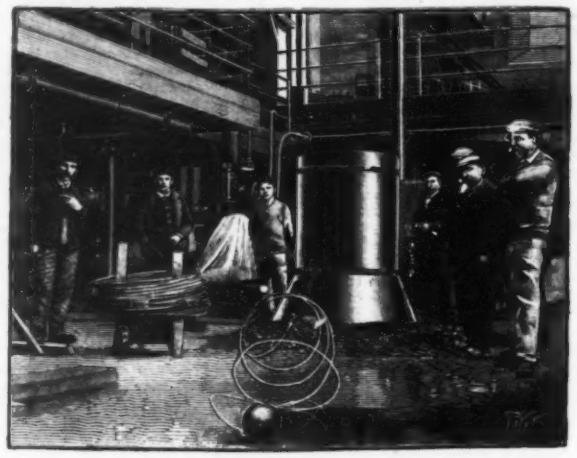


FIG. 1.—THE BALLAST TANK AS IT APPEARS BEFORE THE BALLOON STARTS.

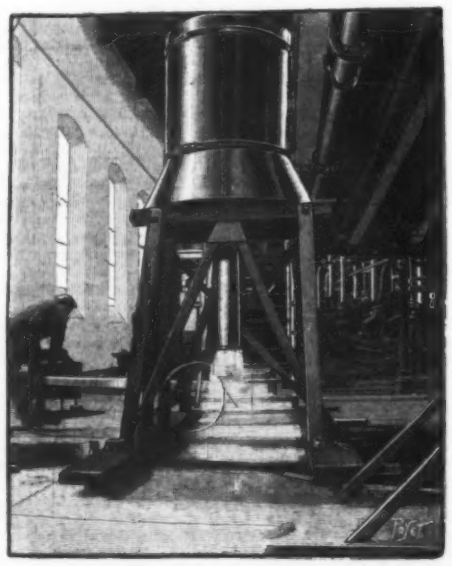


FIG. 2.—BALLAST WATER ESCAPING BY OPEN VALVE.

Fig. 1 shows the tank resting upon a bed of sand, such as is provided for it when the balloon is started. Under these circumstances the ball does not weight the valve, which is therefore open; still the water does not run out, for the tube, by which the water escapes, is clenched under the edge of the tank, and held closed by its weight.

By the side of this tank, coiled up, and laid upon a small truck, will be noticed the heavy guide rope, 2,000 feet long. This rope is made of steel wire and has ten weak points, protected for the journey by covers. These weak points are made to yield to tearing stresses ranging from top end downward between 1,500 pounds and 440 pounds. If, therefore, the guide rope becomes inextricably entangled on the way, the balloon, borne along at a rate of 12 miles an hour by the trade wind, will sever the guide rope at the weak point nearest the portion caught, and continue on its journey with a reduced guide rope.

The normal quantity of ballast served out by the balloon is calculated to be about 44 pounds every five hours, and according to the trials at Chateauroux, each discharge should be effected in the space of 15 seconds, which is just the time taken by the sphere to strike the earth and to rebound. If, however, during this brief interval the wire by which the ball is suspended should become caught, it is so arranged that it would tear, and the valve would close automatically. After this the discharge of ballast would be effected at the required instant by the shock imparted to the tank on striking the earth. It would be a rather coarse measure, but for all that an effective and certain one.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

CAUSES OF ETHER WAVES.

PROF. FRANCIS E. NIPHER, of Washington, recently completed a series of experiments as to the effect of explosions on ether, and is of the opinion that the Mount Pelée eruption has fully proven them. He believed that ether waves could be produced by explosions, and, to convince himself, made a number of tests in the old Washington University building. While sound travels through the air at the rate of 1,100 feet a second, ether waves will travel through anything at the rate of 180,000 miles a second. The question was how to get the ether waves in motion. A score of years ago an explosion on the sun produced ether waves on the earth's surface, scientists declare. If such waves could be produced from a celestial sphere, so many millions of miles away, Prof. Nipher and others believed that a terrestrial explosion would produce the same results. The greatest question was how the disturbance might be created. It was recognized that the explosion should be as violent as possible, in order to produce a magnetic disturbance. With this idea in view Prof. Nipher arranged his laboratory for the experiments. The needle which was to tell if the explosion produced any magnetic disturbance was suspended on a fine silk wire. Underneath the needle was fastened a thin mirror, and at the side, on the wall, was hung a sheet. The slightest vibration of the needle was reflected on the sheet, and from its movements, Prof. Nipher was to determine whether or not his supposition was correct.

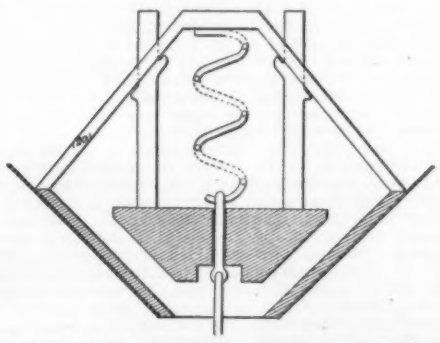


FIG. 3.—VALVE WHICH OPENS AUTOMATICALLY TO SERVE OUT BALLAST.

"The work was attended with great difficulty," said Prof. Nipher. "The buildings and grounds of the university where the work was attempted are in the heart of the city, with street cars continually passing. Only between two and three o'clock in the morning was it possible to obtain brief intervals fairly free from outside disturbances. Even then the needle was continually in motion. The explosions were limited by the possibilities of damage to property. The results so far have not been conclusive. Deflections of the needle have been obtained; but they could not be reduced to any system which could rationally be explained. The explosion on the island of Martinique produced on the needle the same effects which I attempted in the laboratory. The deflections were noticed in Paris, Maryland, Toronto, Canada, Kansas, and the Sandwich Islands,

within a fraction of a second of the same time, which goes to show that the ether waves in all those places were produced by the same cause."

Prof. Nipher will continue his experiments this spring and under better conditions. He hopes to be able to prove conclusively the theory of ether waves from explosions. As to the value of the fact, if proven, he is willing to leave that to be learned later, the same as the value of electricity by induction was learned after its discovery. Chiefly, though, Prof. Nipher believes that, if his theories are fixed, it will be a great aid to the new system of wireless telegraphy.

BOOMERANGS.*

By GILBERT T. WALKER.

BOOMERANGS may be studied for their anthropological interest as examples of primitive art† or for the manner in which they illustrate dynamical principles.‡ But there is extraordinary fascination in making and throwing them, and in watching the remarkable and always graceful curves described in their flight. Accordingly, my chief object in the following paper has been to diminish the practical difficulties of the subject by giving some of the results of ten years' experimental acquaintance with it.

The Australian weapons vary enormously in shape and size, while the skill of the natives in throwing them is great in some districts and very small in others.

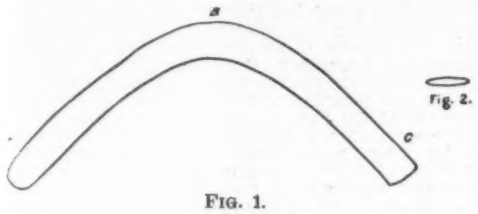


FIG. 1.

The marvelous flights that were described by former travelers are but rarely seen to-day, and although it is undeniable that many a native can make a boomerang go 80 meters away before returning to his feet. I know of only one trustworthy account of a much more sensational throw.§ In this the boomerang described five circles in the air, traveling to a distance of about 90 meters from the thrower and rising to a height of 45 meters.

For present purposes it will be convenient to consider two types of implements. The first (Fig. 1) is about 80 cm. in length, measured along the curve, is bent (at *B*) almost to a right angle, and has the cross section shown in Fig. 2. It is about 6.5 cm. wide and 1 cm. thick in the center at *B*, and the dimensions of the cross section diminish slightly toward the ends *A* and *C*. The weight is about 230 grammes. The arms are twisted from the plane *A B C* after the manner of the sails of a windmill, being rotated through 2 deg. or

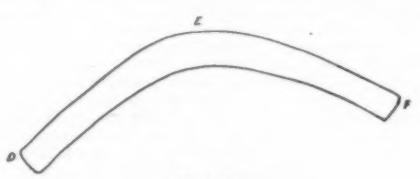


FIG. 3.

3 deg. in the direction of a right-handed screw about the lines *BA*, *BC*, as axes. This deviation from the plane is subsequently referred to as the "twist," and the peculiarity that, as seen in the cross section of Fig. 2, one face is more rounded than the other, is called the "rounding."

Boomerangs of the second type (Fig. 3) are about 70 cm. long and 7 cm. wide, and have a cross section similar to that of Fig. 2. The "twist" is in the opposite direction, involving a left-handed rotation of about 3 deg. The axes of rotation are now *DE*, *FE* instead of *ED*, *EF*.

RETURNING FLIGHTS.

An implement of the first type is held with the more rounded side to the left and the concave edge forward. It is thrown, with plane vertical, in a horizontal direction, and as much rotation as possible is given to it. The plane of rotation does not remain parallel to its original direction, but has an angular velocity (1)

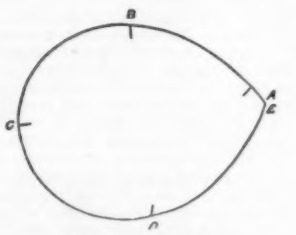


FIG. 4.—PLAN.

about the direction of translation, and (2) about a line in its plane perpendicular to this.

The effect of (2) is that the path curls to the left, while owing to (1) the plane of rotation inclines over to the right (i. e., rotates in the direction of the hands of a clock facing the thrower), and its inclination to the vertical becomes comparable with 30 deg. in two seconds. The angular velocity (2) will now imply that the path bends upward as well as horizontally round to the left.

When the boomerang has described a nearly complete circle its pace has diminished, and it falls to the

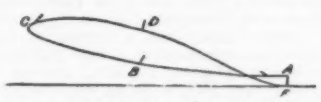


FIG. 5.—ELEVATION THROUGH C A.

ground near the thrower. (See Figs. 4, 5, in which projections on a horizontal and on a vertical plane are given. The direction of the axis of rotation is indicated by giving the projections of a line of constant length measured along it. The scale of these diagrams is about 1:1000.)

The angular velocity (1) is increased by an increase of twist and by an increase of rounding; it also increases when cos θ increases, where θ is the inclination of the plane of rotation to the horizontal. The curling to the left (2) is increased by an increase of

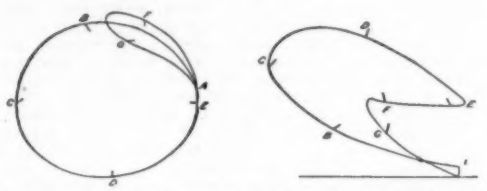


FIG. 6.—PLAN. FIG. 7.—ELEVATION THROUGH C E.

twist, or of cos θ and, in general, by an increase of rounding.

If it be desired that the boomerang should describe a second circle in front of the thrower (Figs. 6, 7), it must be thrown much harder, so that when one circle has been described it may still have sufficient forward velocity. When the projectile has described the first circle and is over the thrower's head, the axis of rotation must point in an upward direction in front of him; if it pointed behind him the subsequent path would be behind his back, and a figure of 8 (Figs. 8, 9) would become possible. For a path with a second loop in front of the thrower he should accordingly choose a boomerang with much twist and much rounding, and throw it with his body leaning over to the left, so that the angle θ between the axis of rotation

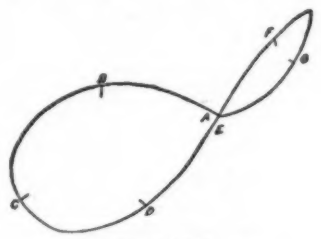


FIG. 8.—PLAN.

and the vertical may be slightly in excess of a right angle. The increased twist will mean that the first circle has a smaller circumference and that there will be more pace left after it has been described, and the increased rounding will keep the plane of rotation from becoming horizontal too soon.

For a figure of 8 we should require less rounding, or we might give more spin in throwing, and aim a little uphill, with θ rather less than a right angle. There are so many elements capable of variation that nothing but experience can teach how to get the best results with any particular boomerang.

The most complex path that the author has succeeded in effecting is that of Figs. 10 and 11. But it is certain that these fall far short of what is done by skillful natives of Australia.

If the angle between the arms is increased and the twist and rounding unaltered, the angular velocity (1)

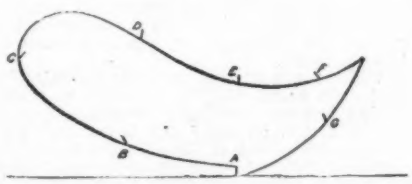


FIG. 9.—ELEVATION THROUGH C A G.

is increased, and it becomes easier to make a second loop behind than in front. If the angle exceeds 150 degs. the angular velocity of the first kind is so large that it is very hard to get a return at all.

When the twist is left-handed and the angle large we have a specimen of the second type (Fig. 3), and it must be thrown with the more rounded side uppermost and the plane of rotation inclined at between 30 deg. and 60 deg. to the horizontal (i. e. 30 deg. $< \theta <$ 60 deg.); the angle of projection (i. e. inclination to the horizon of the initial velocity of translation) must be comparable with 45 deg.

The uphill path is nearly straight until the forward velocity becomes small; the projectile then returns along a track close to that of the ascent (Figs. 12 and 13).

NON-RETURNING FLIGHTS.

A good boomerang of the second type will travel an immense distance in a nearly straight line if properly thrown. The motion should resemble that of an aero-

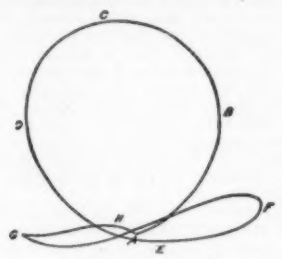


FIG. 10.—PLAN.

plane or flying machine; the plane of rotation must remain nearly horizontal, though slightly uphill, and the trajectory must be flat. There will thus be an upward pressure of air on the under surface of the implement, and the force of gravity will be counteracted as long as there is sufficient forward velocity. The boomerang is thrown very slightly uphill, the angle of projection not being greater than 12 deg.; the rounded side is uppermost and θ is initially 30 deg. The plane of rotation soon appears to the thrower to become approximately horizontal, and it remains so during the flight; the projectile rises to a height of about 12 meters from the ground and travels in a nearly

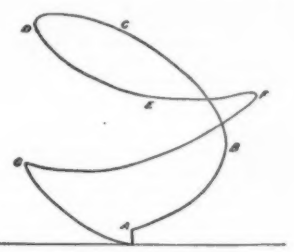


FIG. 11.—ELEVATION THROUGH G F.

straight path until its forward velocity is almost exhausted; it then strikes the earth at a distance of about 130 meters from the thrower.

It will be seen that the angular velocity (1) is at first small and positive, and that it subsequently disappears; the angular velocity (2) is small throughout. These results are due to the left-handed twist and the rounding.

Considerable accuracy, both in making and in throwing, is necessary if the best results are to be obtained. If the plane of rotation slopes downward to one side, the boomerang will slide down in the inclined plane of rotation; thus the path will be bent and materially shortened. The correct relation has to be found be-

FIG. 12.—PLAN.

tween the twist, the rounding, the angle between the arms of the boomerang, the density of its material, and the amounts and directions of its initial linear and angular velocities. An illustration of this is afforded by the first specimen of this type that I have met; it travels farther against the wind than with it. In the former case the boomerang keeps quite low, scarcely rising higher than 6 meters, and being retarded very little by frictional resistance, travels about 125 meters; in the latter case the body spends its energy in running uphill to a height of about 15 meters, and falls to the ground at a distance of about 90 meters.

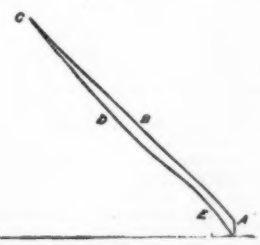


FIG. 13.—ELEVATION THROUGH A C.

It is rather difficult to give sufficient spin to keep the motion stable through a long flight, and I have found it advantageous to wind round the wood about 60 grammes' weight of copper wire in three equal portions, of which one is in the middle and one near each end. This materially increases the moment of inertia about the center of gravity without interfering seriously with other details. I have thrown a loaded boomerang of this type 167 meters, and my range with a spherical ball of half the weight is only 63 meters.

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*Reprinted from Nature, No. 1657, vol. 64, August 1, 1901, in which appears the following note: "This paper is here published by permission of the editors of the Physikalische Zeitschrift, for which it was originally written. A German translation has appeared in that journal, and from its publishers the accompanying illustrations have been obtained."

† The Native Tribes of Central Australia, by B. Spencer and F. J. Gillen (1899), ch. xix.

‡ E. O. Erdmann, Ann. d. Phys. u. Chemie, vol. cxxxvii, p. 1 (1869); E. Gerisch. Zeitschr. d. D. Vereins z. Ford. d. Luftschifffahrt, Heft 8 (1886); G. T. Walker, London, Phil. Trans., vol. cxc, p. 23 (1897).

§ Mr. A. W. Howitt, Nature, July 20, 1876.

MODE OF MANUFACTURE

A block of straight-grained ash about 90 cm. long, 7 cm. (or 7.5 cm.) thick, and of width not less than 7 cm., is taken. The block is soaked in steam, bent to the requisite shape and held in this shape until cool and dry. It is then sawn into strips 1.3 cm. thick. After sufficient time has elapsed for the wood to be seasoned, each strip is trimmed into a boomerang, the most useful tool in general being a spokeshave. It is very important that the outer edge, at any rate in the neighborhood of the bend, should follow the grain of the wood. When the projectile falls hard upon one end the stress near the center is very severe, and any point at which the direction of the grain meets the convex edge obliquely is likely to develop a split and ultimately a breakage.

It is better to cut the material to its final twisted shape rather than to impart the twist by another steaming and bending. Considerable care is required in the process, for the removal of a layer of wood a millimeter thick in such a way as to increase or diminish the twist will cause a marked difference in the flight. It will be found to facilitate throwing to cut that end of the boomerang which is held in the hand to the somewhat square form shown at the right hand of Figs. 1 and 3.

There is some difficulty in avoiding warping, for boomerangs are less likely to get broken if thrown when the ground is damp and soft, and under these circumstances the moisture is likely to be absorbed by the wood. It is of great advantage, therefore, to make the surface of the implements very smooth with fine glass paper and to saturate them with linseed oil. The additional density thereby produced is also of service in that it diminishes the effect of the frictional resistance of the air.

I have used artificially bent oak as a material, but have not found it as heavy or as strong as ash. Oak branches that are naturally bent are not hard to procure, but boomerangs made from them are liable to break at places where there are knots or irregularities in the grain of the wood.

EVOLUTION.

Boomerangs of every variety of shape are still to be found in Australia, and it appears impossible to get direct historical evidence as to the nature of the successive stages of development. But if speculation be allowed, the following series may be suggested:

First, we should have a clumsy kind of wooden sword, curved, but without rounding or twist, and with one end roughened to form a handle; when the intended victim was out of reach it would be natural to throw the weapon, and at short ranges it would be extremely effective. Bad workmanship would involve the frequent production of implements of which one side was more rounded than the other, and it would soon be found that these missiles, when thrown with the rounded side uppermost, traveled much farther and straighter than the former.

Boomerangs of this character vary in length from 50 to 110 cm., and in weight from 200 to 1,250 grammes. They are, for the most part, twisted in a manner that seems quite fortuitous, and form the enormous majority of the present native implements. Light specimens with a slight left-handed twist may have a fairly straight trajectory of 100 meters, and may return if aimed much uphill, especially when thrown against a wind. Those which are bent through a large enough angle and happen to be twisted (either by carelessness in manufacture or by subsequent warping*) after the manner of a right-handed screw are returning boomerangs of the first type. In many of these the twist is so large as to be conspicuous, and when once the connection between the form and the return flight has been noticed, the process of development is complete.

THE LOST CONTINENT STORY.

THE terrible disaster in the West Indies has naturally revived reminiscences of previous occurrences of the same kind in other parts of the world, and all the horrors of similar character which have occurred for ages past have been retold and compared with the latest and perhaps worst of all. It is a singular fact, however, that if there be aught of truth in the early traditions of mankind there once occurred in the West Indian region, or in the Atlantic to the east of the West Indies, the most fearful disaster in the history of the human race, a catastrophe so terrible in its nature as to impress indelibly its history into the mind of the human race and render forgetfulness of it an impossibility.

It has been customary for ages to regard the story of Atlantis, the lost island, as merely a traditionary fable. Students are now more cautious and hesitate ere pronouncing judgment upon a tradition which comes down through the ages with the stamp of undoubted antiquity upon it. The fact that the Atlantis legend has for over 1,000 years been regarded as an idle tale has no influence on the minds of scholars who remember that for the same length of time the stories of Herodotus were equally discredited. He is now known to have been a conscientious narrator of what he saw or knew to be true. Many legends, once discredited like that of Atlantis, are now known to be founded upon fact, so students of antiquity are slowly coming to the conclusion that the Atlantis legend has a solid historical basis.

The tradition was in ancient times most clearly set forth by Plato, who, in "Timæus" gives a full account of the storied island, the narrative being imparted to Solon, ancestor of Plato, by the priests of Egypt, who in their documents had preserved the history of Atlantis as it had been handed down from a still more remote antiquity. Briefly summarized, the account given by Plato and others is this:

To the west of the Pillars of Hercules or Strait of Gibraltar, and at the distance of several hundred miles there once lay a great island. Its dimensions were larger than those of Asia Minor, and either by a short voyage by land or a chain of islands, it communicated with the great continent to the west of the ocean, or America. This island was of itself an empire. Its people attained a high degree of civilization. They had populous cities, carrying on a vast trade both by sea and land; they cultivated the earth, had orchards and vineyards, and their soil produced tropical fruits and flowers, delicacies of many kinds and medicinal plants and herbs. They dug great canals for purposes of irrigation and transportation, they constructed excellent highways, they had a system of laws and a highly organized government. The palace and royal city exceeded in splendor anything known in Europe at that time, the details being curiously suggestive of the descriptions of the royal palace of the Peruvian Incas. They had extensive colonies. One swarm of their population settled Egypt, another the shores of the eastern Mediterranean, finally founding great States in the valleys of the Euphrates and Tigris.

The shores of the Mediterranean, the coasts of western Europe and perhaps also portions of western Africa were under their control, and hints are given, both by Plato and others, of colonies elsewhere. Their country was the original seat of the world's civilization, and from it the knowledge of the arts and sciences, and perhaps of letters and writing also, was carried in every direction to the ends of the earth.

By a tremendous convulsion of nature the continent disappeared beneath the waters of the ocean, its inhabitants perished, its cities were overthrown. The nature of the catastrophe is not exactly stated either by Plato or in the other legends, though vaguely the destructive agent is declared to be water in such immense quantities as to constitute a deluge which reached to the tops of the highest mountains. "The fountains of the great deep were broken up," rains of unprecedented violence continued many days and the flood covered all the earth. A few frightened inhabitants escaped in ships and bore the news of this awful calamity to the rest of the world. In their attempts to explain an occurrence which filled all nations with horror, men attributed it to the vengeance of their gods and found a reason in the real or supposed wickedness of the people of Atlantis which provoked their deities to destroy them.

Such is the story, as derived from Plato, and one or two other sources, of the mysterious island. It is now practically certain that long before the date commonly fixed as that of the flood there were powerful civilized States both in Egypt, Mesopotamia and along the eastern Mediterranean. They possessed in a high degree the arts of civilization. They could write; they had libraries and public records. There were banks and commercial houses; accounts were kept and bills rendered. There were poets and novelists, architects, painters and sculptors. Their civilization, rather than original, however, seems to have been derived from an older source, and the suspicion that this was the case has led students of antiquity more than ever to the belief that there may be much of truth in the hypothesis which makes Atlantis the original seat of all civilization, but the destruction of the great continent did not hinder or delay the progress of man, for the colonies sent forth were strong enough to continue the work begun by the mother country. Traditions of the deluge are not, as commonly supposed, to be found in every land. There is none among the African tribes of the Dark Continent; there is none among the Australian aborigines or South Sea Islanders. The traditions exist only in those countries which are also traditionally associated with the lost continent, or whose inhabitants are descended from its supposed colonists. They are found in Europe, in all parts of Asia, in Egypt, in North, Central and South America, and tradition asserts that all these countries were either settled from Atlantis or had been conquered by the powerful and warlike Atlantean kings.

The total destruction of the mother country would so vividly impress the imagination of all nations associated with the lost continent that the deluge might easily be magnified into the inundation of the whole earth, and no traditions are to be found among the Africans or in the South Seas, because these peoples had nothing to do with Atlantis; had never heard of it, nor of the catastrophe by which it vanished.

The historic evidence in favor of the existence of the lost island is merely traditional, but the universality of the tradition and its persistence give it a weight which cannot be ignored. The narrative of Plato is no fanciful story of gods and heroes; it is a plain, straightforward statement of facts connected with a remarkable people, whose history had been derived directly from the descendants of its original colonists, and the Plato narrative carries conviction by its simple candor and apparent lack of imagination.

Only in the last few years has science come to the confirmation of tradition and rendered it almost certain that at one time far back in the misty past there was actually an island of continental proportions in the Atlantic Ocean.

About fifty years ago the scientific investigation of the sea bottom began with the invention of apparatus for making deep-sea soundings. Government ships of the United States, Germany and Great Britain have mapped out the bottom of the Atlantic, and thus has been made known the existence of a vast submarine plateau reaching from a point in the sea to the west of the British Islands in a southwestern direction to the coast of South America, with a connecting ridge near the center of the Atlantic on to the south. Another ridge passes off in the direction of Iceland. Thus the Atlantic consists of two very deep valleys, with a great plateau between them, the valleys having a depth of from 2,000 to 8,000 fathoms and the plateau of from 300 to 1,500. The Azores and a few other islands are the mountain peaks of this submarine plateau, but they are not the only peaks, for in numerous places the tops of submarine mountains rise within four or five hundred feet of the surface, and in a few instances these mountain summits have been located as isolated rocks, very dangerous to navigation. The plateau has mountain ranges, and many evidences have been found of volcanic agency, still active in some of the islands which remain, and indicated as once present by the character of the specimens drawn from the sea bottom.

Of course it is impossible with present appliances to gain special information concerning the plateau or to ascertain aught of any ruins, if there are any, which may exist at the bottom, but it is altogether probable that at some period in the far distant past there was a great subsidence of the sea bottom, accompanied in all probability by an upheaval of the coasts, both of Europe and America. It is known that the British Islands were once far below the level of the sea, probably to the depth of 1,500 or 1,700 feet, and an upheaval in one quarter signifies corresponding subsidence in another, so out of the cataclysm which destroyed Atlantis may have come a considerable part of the European and American continents.

Confirmatory evidence that land communication once existed between the Old World and the New is furnished by both botanists and zoologists, for the flora and fauna of the two, while not identical, still display so many instances of correspondence as to show that free communication existed. The fossil remains of the camel are found on both continents, the terrible European cave bear was no other than the grizzly; the glutton and the wolverine are identical, the cave lion and the cave wolf of Europe are found in their remains in America, while scores of other instances that might be cited point to only one conclusion. The same correspondences are observed in the plant world, both among species supposed to be native and varieties which have been cultivated from prehistoric times.

The only remaining question concerns the force or forces necessary to accomplish so tremendous a result. Is there a power in nature sufficient to submerge and destroy a continent? Concerning this no one who has read the story of Martinique can doubt. The earthquake, the volcanic eruption can destroy anything. Instances of the submergence of considerable districts have occurred in our own times. In 1819 2,000 square miles of land at the mouth of the Indus sunk beneath the ocean and the towers of the great fort of Sindree are still visible miles from the present coast. The earthquake which destroyed Lisbon shook an area of the earth's surface larger than Europe. There was once a great continent connecting southeastern Asia with Australia; it has vanished beneath the Pacific and the islands which dot the ocean are the tops of its mountains. Under the Atlantic there was a sudden displacement and subsidence of the crust of the earth, probably accompanied by violent volcanic disturbances, the sea rushed over the land, Atlantis disappeared and the few of its people who escaped spread far and near the awful story of the deluge and perhaps became the Noahs of the different nations which date their origin from the colonies of the lost island.—St. Louis Globe-Democrat.

RECENT EGYPTIAN ARCHÆOLOGICAL WORK.

THE annual meeting of the subscribers to the Egyptian Exploration Fund took place in London, Friday, Nov. 7, 1902, says the Evening Post. In reviewing the year's work Sir John Evans, president of the Society, dealt with Prof. Petrie's discoveries among the Royal Tombs and the Temenos of Osiris, at or near Abydos.

The results, published for the most part, yielded one more name to the list of kings before the First Dynasty; and many worked flints of various shapes had gone to illustrate this prehistoric period in museums of England and America. A special extra publication detailing work carried out by Messrs. Mciver and Mace at El Amrah and Abydos was also announced, and the great activity at present displayed throughout the civilized world in matters Egyptological was pointedly dwelt upon. Next, Sir John spoke of the Archæological Survey, and of Mr. Davies's facsimile work, which has this year supplied important omissions in and given connection to the scenes of the tomb of Mery Ra, the largest and finest in the northern cliff near Tel el Amarna. Mr. Davies also visited Thebes, and secured a complete record of the important tomb of a Theban magnate, Aba. This tomb, and the small ones of the southern group, are the subject of the first volume of Deir el-Gabrâwi, in the publications of the Survey. The second volume will give the remaining tombs, identifications by an expert (Mr. Boulenger) of the fishes there sculptured, and a chapter by Mr. Crum on the Coptic *graffiti*. This will clear the docket of the Survey. Its next year's memoir is "already far advanced," and of exceptional interest because of its display of "the art of the heretic period in all its strangeness." A strong appeal for more adequate support for this department of the work was then in order.

Sir John next turned to the labors and publications of the Græco-Roman Branch, adverting to the large volume of Tebtunis Papyri just placed in the hands of subscribers as representing their subscriptions for the years 1900-'01 and 1901-'02. "We are indebted," he said, "to the University of California, which provided the funds for the excavation, for the necessary number of volumes (at an agreed price) to supply our subscribers." These papyri were obtained from the wrappings of mummified crocodiles disinterred at Umm el-Baragât in the Fayûm, and Drs. Grenfell and Hunt enjoyed the help of Mr. J. G. Smyly in their decipherment. The documents ranged from 120 to 90 B. C.—a few coming down to B. C. 56. There were three fragments of anthologies or epigrams, and an extract from the second book of the Iliad (eighty lines); but the bulk of the volume consisted of political and economical documents of the later Ptolemaic period, ordinances of Euergetes II. and Soter II., official letters and local petitions. Of these last, one concerned a burglary by which a robe and tunic belonging to the petitioner's mother were feloniously appropriated. They were valued at one talent 4,000 drachmas, and at 4,000 drachmas. "Strange as it may seem, there were dining-clubs in those days, of the accounts of which portions are forthcoming. The members at each dinner were usually about twenty in number, and each paid 100 drachmas, exclusive of wine, bread, and garlands. The names of the guests, usually about four, are given on a separate list. Finally, after a reference to Appendix II., with its conclusion that, for the second century B. C. the accepted view that the ratio of a silver to a copper drachma was 120 to 1 must yield to a ratio varying from 500 to 1 to 375 to 1, and,

* This may be illustrated by the fact that when the author first made boomerangs he was only aware of the need for rounding; but the first two specimens that he constructed happened to have right-handed twist and returned admirably.

after intimating that this newly established ratio would make the petitioner's valuation of his mother's stolen attire a less exorbitant one, Sir John offered his congratulations to the learned decipherers of these papyri. It may not be amiss to advert here to the circumstance that the generous American subscriptions to the Fund have not been at all proportionately given to the Græco-Roman branch. The value of these papyri to classical learning is so great that it seems not unreasonable to expect those interested in the classics to come forward generously in the future.

The third volume of the Oxyrhynchus Papyri was announced for publication in July next; it will contain portions of two odes by Pindar, a large fragment of Menander's "Kolax," two mimes, one partly in verse, a fragment of the "Cesti" of Julius Africanus concerning a MS. of Homer's Odyssey found by him in Palestine, a fragment of Plato's "Gorgias" and of the "Iliad," and also a fragment of Baruch's "Apocalypse" in the Greek original, now first brought to light as the source from which the current Syriac version is derived.

Prof. Flinders Petrie had much to say on the subject of building up the history of the early Egyptian dynasties. "Few perhaps realize," he said, "that what is quoted now as a matter of course in the order of the kings was entirely brought to light only two years ago in 'Royal Tombs.'"

Scarcely a single conclusion had been modified in the two succeeding years which had built up so much more. The main work of last winter was "the reading page by page of the successive levels of the early town of Abydos." An exact continuity between the end of the prehistoric age and the beginning of the 7,000 years of written record had been determined entirely as the result of archæology. Our knowledge has gone through four stages; gold-hunting, art-hunting, inscription-hunting, and archæology-hunting. Each stage had been despised as foolishness by those which preceded it, each in its turn had shown a wider interest, a greater importance in the remains of past civilization.

For the coming year's work there was the great site of the oldest Abydos temple, cleared as yet only down to the Eighteenth Dynasty level. The two or three yards of accumulations now left must contain older remains of the temples rebuilt by earlier kings. A series of temples had left their marks, and, he said, the goal sought after was the Temple of the First Dynasty kings on a site which is under the water level until late in the spring. It would be necessary to do the costly work of removing all the upper layers in order to dry the soil below, and finally to work, perhaps, under water.

Two immense Twelfth Dynasty tombs found last year would have to be cleared out. Here the lavish care of the work was attested by red granite sarcophagi of vast size, and hundreds of square yards of polished quarzite, which Mr. Petrie had actually seen in one of them. We might hope for fine objects from these passages and chambers. Also the excavation of the large fort of the Old Kingdom and of the great cemetery of Abydos was by no means yet completed. So large, indeed, was the amount of work that the committee had agreed to join more workers together, and, he said, "we got out this year a much larger party of united workers than we have ever had before." Mr. Hugh Stannus, a skilled architect, Mr. Currelly, Mr. Rawnsley, and Mr. Ayrton were each to take some part in charge. Miss Hansard had volunteered to give help in artistic drawing, and Miss Eckenstein would attend to camp work on the collections. His own business would be "organizing, arranging, and interpreting the work, drawing and preparing for publication." "Thus," he added, "we shall be a party of nine, and hope to get through in one season what on the old rate would have taken three years." Such a staff would render the Fund less dependent than before on the health of any one person whatever. Indeed, it was the duty of the Society to rescue what they could in Egypt before it was "entirely wrecked by the dealer, the ignorant amateur and speculator, and the commercial destroyer," none of whom left a shred of information. None but the present generation could perform this duty, said Prof. Petrie, because, "at the present rate of wreckage, there would be but little left behind for future lives to explore;" and he closed with the pregnant and pointed sentence: "Now is the time!"

COMPLETION OF THE SOUTH AFRICAN SURVEY.

THE Chartered Company of South Africa has organized in London a well equipped expedition for dispatch to South Africa to complete the scientific survey of the continent so far north as Lake Tanganyika. The task will occupy at least three years. The government of Cape Colony has already completed the geodetic survey of South Africa from Cape Town to the borders of Rhodesia, while a certain area of the latter country has also been similarly surveyed, but the scope of the work was limited. Now, however, that the Cape to Cairo telegraph has been completed right up to the shores of Lake Tanganyika the work of the expedition will be greatly facilitated, as during the journey it will be possible to maintain communication by the telegraph, and thus synchronize with the observatory at Cape Town—an essential part of the observatories. The survey is to be carried out under the supervision of Sir David Gill, the Astronomer Royal in South Africa, but the actual leadership of the expedition is vested in Doctor Rubin, of Upsala, who until recently was engaged in the geodetic survey of Spitzbergen. He will be assisted by six scientists, a doctor, and will be provided with a large caravan. As the arc of meridian has already been determined as far north as the Zambesi River, Dr. Rubin will commence his work from a point thereon, and then work northward to the Lake Tanganyika. The results of the expedition and survey will be of inestimable benefit from a geographical, as well as the scientific, and other points of view, since the present maps of the country to be surveyed are very imperfect and incorrect. From Lake Tanganyika, as the country is German territory, the survey will have to be continued by the German government as far north as Uganda.

TRADE NOTES AND RECIPES.

Strong Pack Thread.—An extraordinarily strong pack thread or cord, stronger even than the so-called "Zuckerschnur," says the Pharmaceutische Centralhalle, may be obtained by laying the thread or fibers in a strong solution of alum, and then carefully drying them. Threads thus prepared are practically unbreakable.

Gold-Plating of Metals by Automatic Reduction.—A German patent has been issued to one Göttig (Chemische Zeitung) for an aromatic process of decomposition of gold on metallic surfaces, which, if practical, is destined to work quite a revolution in the gold-plating industry. The process is briefly described as follows: An aqueous solution of gold chloride is decomposed by suitable sulphur compounds (sodium sulphide, sodium arsenic persulphide, the rhodanates, etc., for instance), the gold being reduced and attaching itself to metal surfaces. Various colors are produced by the addition of alcohol, oxalic acid and other organic substances. Sodium sulphide solution, and alcohol, with polishing materials (*Putzmittel*) give a brownish hue; sodium-arsenic persulphide and alcohol, a red; ammonium rhodanide with alcohol and oxalic or tartaric acid a yellow, etc. These depend, however, very much on the substance to be gilded. The concentration of the gilding fluid depends upon the rapidity with which the result is to be attained and must naturally be much higher when the liquid is penciled or painted on than when the objects are simply immersed in the liquid.—Chemische Zeitung.

Economical Process for the Preparation of Packing Material.—This process for the preparation of packing, impermeable, imputrescible, and unattackable by chemical agents, includes two successive impregnations of tissues or papers designed to serve for the packing. The operation takes place preferably on the piece before cutting.

The first bath has for its base a mixture of low-priced hydrogen carbides, combined in such a way as to present a soft consistency at the ordinary temperature. These matters are for example various tars, paraffine, bitumen, asphalt, colophony, ozokerite, ceresine, mineral oils, and the residues of their distillation and purification, caoutchouc, gutta percha, balata, etc. The best results are obtained by the use of tarry residues produced by the treatment of mineral oils with sulphuric acid. These hydrogen carbides are carefully neutralized and heated until complete fusion. They may be thickened to a syrupy consistency by the addition of any pulverulent matters, and small quantities of oleine, mineral oil, or antiseptics may be added.

The packing material is immersed in this melted mass and pressed between heated cylinders. Afterward, it is treated with a second bath. This consists of an alkaline silicate or a mixture of pulverulent matters and an agglutinant liquid (aqueous solutions of glue, alkaline silicates, resin soaps, etc.). In this mixture the paper pulp may be introduced, or it may be employed exclusively.

The second bath is kept at a temperature lower than that of the first. The packing is cooled to a certain point, and the mass from the first bath is solidified. It is covered on both faces with a thin coating of the material of the second bath, of which the thickness is regulated and the adherence increased by a new pressure between cylinders not heated.

The materials thus prepared are quite valuable for the transportation of lime superphosphates and other corrosive substances, as well as for such products as cement, which it is important to preserve from exposure to moisture.—From the French in La Revue des Produits Chimiques.

Varnishes for the Paper Trade.—In the paper manufacture, and especially in the production of leather imitation and colored papers, varnishes and varnish-like liquids prepared with shellac, casein, albumen, etc., are used. Following are some very useful receipts for mixing which will prove valuable:

1. Black Varnish for Calf-Leather Paper.—In an enameled vessel soak for 24 hours 2 parts, by weight, of logwood extract with ½ part, by weight, of strong spirit of sal-ammoniac in 22 parts, by weight, of water. In another vessel dissolve 2 parts, by weight, of shellac with 2 parts, by weight, of spirit of sal-ammoniac in 6 parts, by weight, of water. After 24 hours dissolve the logwood extract perfectly, add the shellac solution slowly and with constant stirring, allow to settle, and draw off the finished varnish from the sediment.

2. Silk Black is a varnish which is destined for a single coating of silky gloss, hence without priming. Dissolve 10 parts, by weight, of logwood extract in 50 parts of water; after settling for several days pour the solution into a clean vessel and add in rotation, stirring each time: 1,875 parts of Venetian soap dissolved in 15 parts of water, 2 parts of dextrin in 4 liters of water, 0.880 part of potassium chromate in 6 parts of water, and 2 to 5 parts of shellac in as much spirit of sal-ammoniac and 15 to 20 parts of water. (All parts by weight.) After the last admixture, stir for one-half hour more, and filter off hot.

3. High-Luster Varnish.—In a suitable vessel dissolve: Shellac 2½ parts and gallipot 2½ parts in 6¾ parts of alcohol, add 1½ parts of Venice turpentine stirred thin with ½ part of alcohol, and admix 3½ parts of strong spirit of sal-ammoniac with constant agitation. After leaving alone for two days, add with thorough stirring 10 parts of water. (All parts by weight.) The luster of the varnish improves with the length of time it is stored.

4. Varnish for Tracing Paper.—In a tin pail provided with a tightly closing cover dissolve in the water-bath: Rosin 9 parts, dammar 4 parts, and camphor 2½ parts (all by weight) in oil of turpentine 10 parts; if it turns out too thick, add a little turpentine oil, so that the varnish finally possesses the consistency of thin purified syrup. The varnish, which is to be filled in bottles, is diluted, by the liter (or quart), with about the same quantity of oil of turpentine, and applied with a clean sponge on the paper. In rolling up the paper coated with varnish, a sheet of unvarnished paper is rolled in with it, which is then saturated with varnish from the other paper.—Farben Zeitung.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Quinine Auction in Batavia.—Consul B. S. Rairden reports from Batavia, January 6, 1903, that the last public tenders for quinine for the year 1902 were received at the office of the agents of the Bandoeng quinine factory, in Batavia, on December 30. The entire quantity (about 2,145.12 kilogrammes, or 4,729 pounds) was sold for 16.65 florins ($6.69) per kilogramme (2.2046 pounds), or a unit price of 0.0607 florin (2.44 cents), as against the unit price of 0.06 florin (2.4 cents) realized at the sale of the 27th of November, 1902.

Use of Tiles in German Meat Shops.—Americans visiting Mannheim frequently comment on the attractive meat shops to be seen here. This attractiveness is secured largely by the use of ornamental tiles for floors, walls, and even ceilings and counters.

The tiles on the walls are similar to those used in bathrooms in the United States. They are generally of light shades, arranged in patterns of artistic design. The floors are also laid with tiles of different colors. These tiles, however, are unglazed and are heavier and of cheaper quality than those on the walls.

In one of the most attractive of these stores, the walls are of ivory-colored tiles, with panels of flowers and other designs. The counter, which runs along two sides of the room, is of the same ivory-colored material, ornamented in gold. It presents a rich, handsome appearance. Even the bookholders, scales, and gas fixtures are tiled. The general effect of the room is suggestive, above all, of cleanliness.

Stoneware furniture for stores is a novelty in Germany, and seems to be applicable especially to meat shops, fish and other markets, kitchens, scullieries, etc. The most important center for its manufacture in this country is Mettlach, where there are several large factories.—H. W. Harris, Consul at Mannheim.

Direct Shipments of Grapes from Spain.—The disastrous experience of the last few years in the exportation of Almeria grapes to the United States will, it is believed, bring about a decided change this season, which will assuredly be beneficial to exporters, receivers, and consumers.

It has been the custom to ship about half the grapes destined for the United States to Liverpool and there transfer them to the North Atlantic liners. This method has always caused a great deal of trouble and in many cases serious loss to the growers. In the rush of loading at Liverpool, the marks would get mixed, so that barrels bearing the same mark would be landed at different piers in New York, or the manifests of one steamer would contain barrels not on board, or barrels intended for sale in England would be shipped by mistake to New York. To remedy this state of affairs, the receivers in America and the agents of the various steamship lines in Almeria, backed by the larger exporters, will use every effort to ship the grapes in direct boats, not only to New York, but to Boston, if the demand at the latter point is great enough.

Direct boats will undoubtedly insure better fruit for the consumers and also enable the receivers to place the grapes on the market much more quickly than under the present system.

The theory that grapes keep better when transshipped at Liverpool, allowing exposure to the air at that point, has been well-nigh exploded.

For the past three years, direct boats suitable for the green-fruit trade have been hard to get, and it is expected that this will be one of the drawbacks this year in the realization of the project.

It might be worth while for our American shipowners—who have already developed some Mediterranean trade—to compete for a portion of the 300,000 barrels shipped every year to America. The season is unfortunately for only two months (from the last of September to the second week in November), but, in conjunction with an established trade, a call here for 8,000 to 10,000 barrels would undoubtedly be profitable.

The freight last year averaged 40s. ($9.72) per ton. Twenty-five barrels of grapes make a ton, and these occupy a space of 80 cubic feet in the ship's hold. The shippers demand that the barrels shall be stowed in such a way as to allow the free circulation of air, and that there shall be sufficient ventilators fore and aft.

I give below the harbor dues and other expenses incident to the shipment of grapes for the port of Almeria:

Transport tax of 3s. (73 cents) per ton of 25 barrels, collected by ship for account of receivers.

Pilotage, about $11 gold.

Stowage of barrels in hold of ship, about 28 cents a ton, regulated by private agreement.

Fumigation, about $6 gold; every ship is required to be fumigated.

Certain gratuities, which amount to from $8 to $12 gold.—A. E. Carleton, Consular Agent at Almeria.

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No. 1605, March 27.—*Direct Shipments of Grapes from Spain—Port Regulations of Tamatave—*Milk Flour in Sweden—Production of Saltpeter from Air in Germany.

No. 1606, March 28.—*Use of Tiles in German Meat Shops—Manufacture of Quartz Glass in Germany - Standardization in Great Britain—Competition for the Palma International Rifle Match.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

SELECTED FORMULÆ.

Alum Baking Powder.—

Ammonium alum, anhydrous	15 parts
Sodium bicarbonate	18 parts
Corn starch, q. s. to make	100 parts

Mix. The available carbon dioxide yielded is 7½ per cent or 8 per cent.—National Druggist.

Antiseptic Shaving Soap.—

Hard paraffin (130 deg. F., melting point)	22 parts
Beef tallow	3 parts
Potash soap	2 parts
Boiling water	68 parts

Put the paraffin, tallow and soap in a suitable vessel, on the water-bath, raise to the melting point, then add the boiling water, under constant stirring, which should be maintained until a complete emulsion is obtained. Let cool down, still keeping up the agitation, to 100 deg. F., then add, all at once, 2 parts of tragacanth in powder, 2 parts of glycerin and 1 part oil of lavender, and stir until the mass sets.—Apotheker Zeitung.

Cement for Glass, Porcelain, etc.—

Isinglass (fish glue)	50 parts
Gum ammoniac	4 parts
Gum mastic	2 parts
Alcohol, 95 per cent	10 parts
Water q. s.	

Soak the isinglass in cold water over night, or until it has become swollen and soft throughout. In the morning pour off any superfluous fluid and throw the isinglass on a clean towel or other coarse cloth, and hang it up in such a way that any free residual water will drain away. Upon doing this thoroughly depends, in a great measure, the strength of the cement. When the gelatin has become thoroughly drained put it into a flask or other container, place it in the water-bath and heat carefully until it becomes fluid, being careful not to let it come to a boil, as this injures its adhesive properties (the same may be said in regard to glues and gelatines of all kinds). Dissolve the gums in the alcohol and add the solution to the gelatin after removing the same from the water-bath and letting it cool down to about 160 deg. F. Stir well together or mix by agitation.

This is a modification of the celebrated "Armenian" cement so called, formerly used by Turkish and oriental jewelers generally, for setting precious stones, "facing" diamonds, rubies, etc. It is as follows:

Mastic gum	10 parts
Isinglass (fish glue)	20 parts
Gum ammoniac	5 parts
Alcohol absolute	60 parts
Alcohol, 50 per cent	35 parts
Water	100 parts

Dissolve the mastic in the absolute alcohol; dissolve, by the aid of gentle heat, in the water-bath, the isinglass in the water, and add 10 parts of the dilute alcohol. Now dissolve the ammoniacum in the residue of the dilute alcohol. Add the first solution to the second, mix thoroughly by agitation, and then add the solution of gum ammoniac and stir well in. Finally put in the water-bath, and keeping at a moderate heat, evaporate the whole down to 175 parts.

If you make up this, or in fact any cement for glass, porcelain, etc., in the directions which should go along with the package, you should impress upon the purchaser the necessity of observing the following precautions: 1. Both surfaces to be joined must be absolutely clean, free from dust, dirt, grease, etc. 2. Where the cement is one that requires the application of heat before use, the objects to be united should also *be heated to a point at least as high as the melting point of the cement*. Otherwise, the cement on application is chilled and consequently fails to make a lasting joint. 3. The thinner the layer of cement the stronger the joint; avoid, therefore, using too much of the binding material. Cover both surfaces to be united, coapt them exactly, and press together as closely as possible. In this manner the thinnest possible layer is secured. 4. Bind the parts securely together, and let remain without loosening or attempting to use the article for two or three days or longer. Remember that a liquid cement only acquires its full strength after evaporation of the fluids used as solvents, and this can occur only from the infinitesimal line of exposed surface.—National Druggist.

Furniture Polish Liquid.—

Shellac, orange	4 parts
Alcohol (wood) 95 per cent	32 parts
Linseed oil	32 parts
Oil of turpentine	16 parts
Ether, sulphuric	4 parts
Ammonia water	4 parts

Dissolve the shellac in the alcohol, add the oil of turpentine to the linseed oil, and mix with the solution of shellac. Finally add the ether and ammonia and agitate until well mixed. When used shake lightly and apply with a soft sponge, and let dry spontaneously. This is the best known application for old and tarnished varnishes.

As in the former case, all dirt, grease, etc., that can be removed by washing, should be scrubbed off. In fact, this rule applies to the use of every furniture polish, and should have a prominent place on the label or "directions."

This polish may be made more cheaply and probably just as well by the following modification:

Shellac	4 parts
Wood alcohol	32 parts
Carbon disulphide	1 part
Peanut or cotton seed oil	100 parts
Tincture of benzoin	65 parts
Tincture of myrrh	5 parts

Mix the carbon disulphide and alcohol and in the mixture dissolve the shellac. Filter the solution and add the other ingredients as named. In making this polish up on a large scale considerable saving may be made by using wood alcohol in making the tinctures of myrrh and benzoin.—National Druggist.

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